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THE GENUS JUGLANS IN MEXICO AND CENTRAL AMERICA

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WALNUTS AND BUTTERNUTS, *nogal* or *nogales* in Latin America, well known important timber and nut trees belonging to the genus *Juglans*, of the Juglandaceae, occur in the New World from eastern Canada to Argentina and from the West Indies and Florida to California. The genus is missing in the modern flora from the northwestern states. In Central America walnuts have not been reported as native from Salvador, Nicaragua, Costa Rica, and Panama. The trees grow primarily in a humid, temperate climate, so that those which grow in the tropical latitudes are restricted to rather high altitudes with good rainfall, and those of arid regions are restricted to the canyons of streams. Consequently, the localities where *Juglans* occurs in Mexico and Central America are comparatively few and the trees are difficult to locate.

The species of Latin America are closely related to those of the United States and two of them occur in both Mexico and the United States. In the United States Sargent (1933) recognized six species, and gave an excellent treatment of these, with illustrations. Some authors recognize five species, others four. The writer recognizes five species: *J. cinerea* L. and *J. nigra* L. in the east, and *J. microcarpa* Berlandier (formerly called *J. rupestris* Engelm. ex Torrey), *J. major* (Torr.) Heller (included by many under *J. rupestris* as a variety), and *J. californica* S. Watson (including *J. hindsii* Rehd.) in the south and southwest. Of these species of the United States, *J. cinerea* clearly does not enter Mexico; *J. nigra* and *J. californica* approach the border of Mexico but have not been reported within that country; the other two species occur in north-central and northwestern Mexico.

The first species published for Mexico and Central America was *J. pyriformis*, described in 1850 by the Danish botanist F. Liebmann from the region of Mount Orizaba, near Coscomatepec, in the state of Vera Cruz, Mexico. The first treatment of *Juglans* of Latin America as a whole was that of Dode (1906-1909), who, in his comprehensive fully illustrated survey of the genus *Juglans* of the world, lists only two species for Mexico and Central America: *J. pyriformis* Liebm. and *J. mollis* Engelm. Standley, in his thorough treatment of the trees and shrubs of Mexico

in 1920, gave four species, the two above for eastern Mexico, and *J. rupestris* Engelm. ex Torrey and *J. major* (Torr.) Heller extending from Texas, New Mexico and Arizona into north-central and northwestern Mexico. Definite descriptions were not made of any species of the genus from Central America until Standley and Williams described *J. olanchana* from Honduras in 1950. Manning, in Standley & Steyermark's Flora of Guatemala (1952), described *J. guatemalensis* and *J. steyermarkii* from that country.

Since the time of Dode many collectors, primarily from the United States, have made trips to Mexico and Central America. In 1953 the writer and his wife made a trip of over 5000 miles in Mexico under the auspices of the American Philosophical Society, primarily to collect and study *Juglans* and *Carya*. As a result of these activities, we have acquired a much better idea of the species of *Juglans* in the area under consideration, and of the distribution of these species.

All species of *Juglans* of the new world, with one exception,¹ belong to the section Rhysocaryon of Dode, typified by *J. nigra*. Dode (1909, p. 166) gives a description of the section. It is characterized by having, (1) a secondary as well as a primary partition in the nut so that the lower part of the nut is 4-celled; (2) each staminate flower with a stalk, and with the floral receptacle round; (3) the husk persistent on the nut; (4) the nut surface ridged or striate in various ways, but never smooth or rugose; (5) the nut dehiscent only at germination; (6) the scales of the embryo of the seed and younger part of the seedling spiral, gradually increasing in size until the normal leaves are reached; (7) the embryos of the seeds with shoulders or lobes near the apex ("shoulder region of the embryo lobes concave" according to Scott, 1954), so the embryo is 5-lobed and the nut 5-celled near the apex; (8) the leaflets serrate; (9) the leaf-scar without a hairy fringe or "mustache," but with a definite notch, along its upper edge. Some of these features were not given by Dode, but have been added by Nagel (1914), Manning (1948), and Scott (1954).

The species of *Juglans* of the world, as well as those of the other genera of the family, arranged by sections, are listed by the writer in his paper on the staminate flowers of the family (Manning, 1948). Two species mentioned there were not published until 1952 and another of those listed will be described in this paper. *Juglans glabrata*, mentioned there, is here reduced to a variety.

All of the species of Mexico and Central America, as well as in the New World as a whole, are so closely related that it is difficult to distinguish them. The writer recognizes five species in Mexico, and two others in Central America, one of the latter represented by a variety in southern Mexico. Two taxa from western Mexico, here described as varieties, may, upon further study, prove to be distinct species.

¹ *Juglans cinerea*, the butternut, is a member of the section Trachycaryon of Dode; the writer does not consider this section distinct from Dode's section Cardiocaryon of Asia, an opinion shared by Nagel, 1914, who, however, uses different sectional names.

Although Dode (1906-1909) did little work on the Mexican and Central American walnuts themselves, his contribution is the only comparatively recent world-wide study of the genus, and the only one on the *J. nigra* section. Furthermore, he studied intensively the species which occur in Texas, New Mexico, Arizona, and northern Mexico. Consequently we must examine carefully his criteria for distinguishing species. It should be pointed out, however, that most students of *Juglans* have ignored most of Dode's species, apparently because he based his new taxa on extremely variable features, so that almost every fruiting specimen constituted for him a new species. His treatment does bring out the amount of possible variation along certain lines.

The key of Dode (1909, pp. 166-168) to species of the section *Rhysocaryon* is based on nuts. He states that this key has only relative value, it presumably being necessary to use the key along with vegetative and floral features found in the descriptions. In this key he divides the species into three groups: A, nuts with ridges more or less sharp (*J. nigra*); B, nuts with ridges more or less obtuse (*J. pyriformis*, *J. elaeopyren*, etc.); C, nuts with striations (*J. mollis*, *J. torreyi*, *J. rupestris*, etc.). These features are important. They are, however, rather difficult to define, and there are wide variations within the species.

Additional but more unreliable features used by Dode in his key are the shapes of nuts, the compression of nuts, the wings of nuts, the size, shape, and number of lacunae (cavities in the outer wall of the nut as observed in a cross-section through almost the exact center of the nut, at least as used by Dode), and the height of dorsal or secondary partition (high, medium, low). On these additional features Dode has divided what most authors consider one species, *J. nigra*, into six species, and what most authors consider one or at most two species (*J. microcarpa* or *J. rupestris*, and *J. major*) into six species.

We can study *Juglans nigra*, the basic taxon for the section, as a criterion for many of these characters.

Certainly there is a decided variation in shape of nuts from tree to tree of *J. nigra*, from subglobose to depressed to elongate, these variations recognized by all American botanists as belonging to one species. Most nuts of *J. nigra* are compressed parallel to the primary partition, but the amount of compression varies.

The wings or dorsal lips of the nut along the suture, resembling those of the nuts of *J. regia*, seem to be variations on individual trees and of no value for specific distinctions in this section.

The writer has made an intensive study of the lacunae of the nuts of *J. nigra* and finds that the number and shapes of lacunae vary, not only in the nuts of trees side by side, but also from level to level of the same nut (typically 8 near the base of the nut, 4 elongate ones in the middle because of the fusion of these in pairs, then 8 toward the apex, with suppression of lacunae and intermediate conditions in different nuts). Scott (1954) has illustrations of consecutive cross sections of one nut of *J. major*, which is similar to, but somewhat less complicated than, *J. nigra*.

There is a possibility that the presence or absence of primary wall lacunae (at each end of the primary partition) may be distinctive, but more study of this feature is required.

The height of the dorsal partition, as seen in a carefully made longitudinal section of the nut along the secondary partition or, better yet, the section seen along the half of the nut following the natural dehiscence at germination, has been used by Dode in separating various species. It is true that the dorsal partition is high in all nuts of *J. nigra* observed by the writer, but the difference in height in the nuts of different species is so slight in the Latin American species, or else the variation is so great, that this feature is difficult to use.

There are other fruit features (husk and nut) not given by Dode in his key, though some of these are given in his descriptions. The writer has found the pyriform condition of the fruit (fruit with a basal or apical projecting neck or both) extremely unreliable, with fruits varying in trees side by side. The thickness of the husk is an uncertain feature, as very few fruits have been collected in the fully mature stage, with dependable notes, and the husk shrinks in drying. All Latin American fruits seem to have a husk thinner than that found in *J. nigra*. In some species, such as *J. pyriiformis* and *J. olanchana*, the husk is conspicuously verrucose due to the presence of large, open, flat-topped warts. In other species, as in *J. nigra*, the warts are more numerous, smaller, raised, but not open and only give the fruit a rough appearance. In still other species the warts are very inconspicuous, partly because of the presence of numerous hairs. Strangely enough, Dode did not use the size of the fruit and nuts as criteria in his key. Although this feature must be used with caution because of the overlapping extremes due to variations on individual trees and to climatic conditions, it is important.

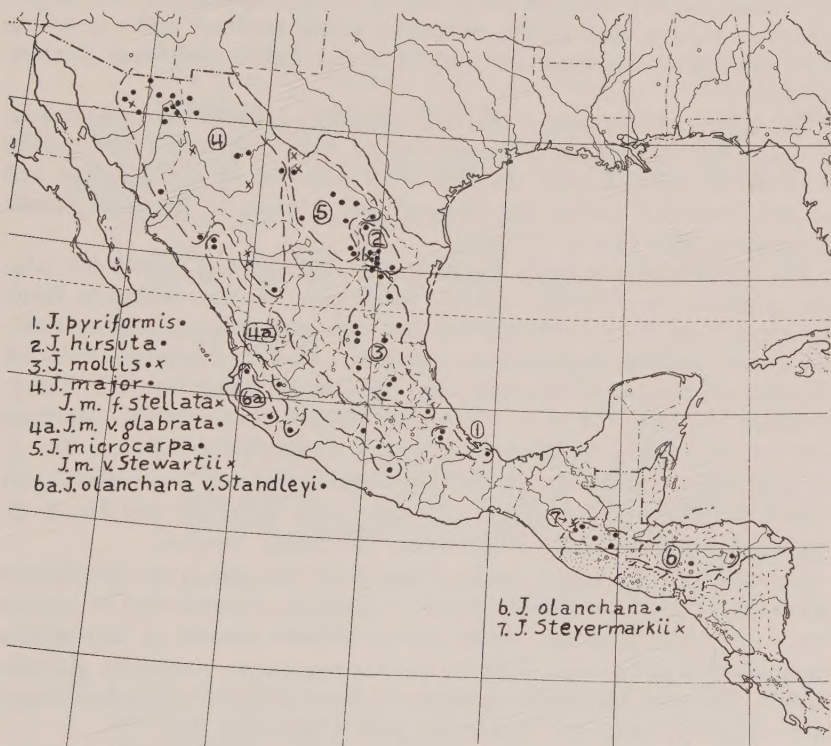
The length of the pistillate spike and the type of hairiness of the individual pistillate flowers are of some value.

In the staminate inflorescences the length of the catkin is in some cases useful. The position of the bract of the individual flower of the median, not basal, flowers along the catkin, seems to be important. This bract may be located: (1) at the base of the pedicel, therefore along the rachis of the catkin; (2) at the middle of the pedicel; (3) at the apex of the pedicel, hence at the base of the floral receptacle; or (4) essentially at the apex of the flower on its dorsal side just back of the two bracteoles (see illustration in Manning, 1948, *figs. 10, 11*). The term "at back of flower" is sometimes misleading and should be used only for position 4, the common condition in most species. In many cases, as explained by Manning (1948, p. 619), the position of the bract changes from the lower flowers to the median flowers of a catkin, so the lower flowers must not be used. The number of stamens seems to be a reliable feature, but there are cases where the number is higher than normal in individual flowers or plants.

In the leaves the number of leaflets is fairly constant for a species, though there may be a difference between the leaves on rapid and slow

growth. The base of the leaflet is a very important feature, whether truncate or rounded as opposed to cuneate or narrowed in some way toward the base. This feature is obscured by the oblique condition of many leaflets, and does not show well on poorly pressed specimens. In some species the leaflets are decidedly stalked.

Hairiness of twig, rachis, upper surface of leaflet, and especially of the lower surface of the leaflet are important, each species having a definite limit of hairiness. It is necessary to define terms used for pubescence. There are two basic types of hairs: solitary, gland-tipped, multicellular pale or colored hairs, and pointed, non-glandular, one-celled pale hairs. On the rachis the former may be extremely short, consisting of essentially stalked glands so that the rachis having these numerous hairs may appear glabrous unless a strong lens is used, and the rachis may be described as minutely puberulent or even glabrate; or the hairs may be medium in length so that the hairs are evident but not conspicuous without a lens, and the rachis may be described as pubescent; or the hairs may be long and conspicu-



MAP 1. Distribution of the taxa which are treated in this paper. The dots indicate localities recorded in this paper, except where distributions overlap; some of these localities are indicated by "X"; the "X" for *J. mollis* is near Monterrey, just below "2".

ous, so that the rachis may be described as villous or even hirsute. Students, of course, will vary in their interpretation, and young leaves with undeveloped hairs will be misleading. The pointed hairs, common on the lower surfaces of the leaflets, may be solitary, in pairs, or in fascicles of three or more, these, of course, representing a branched condition of one true hair. To a certain extent all young leaves of *Juglans* may have fascicled hairs on the lower surfaces of the leaflets, but only in certain species are the leaflets fascicled-hairy, or tomentose, at maturity. In *J. mollis*, and frequently also in *J. hirsuta*, the permanent fascicle of hairs seems to be growing out of a short, yellow, glandular, basal cell. Some of the fascicled hairs present on young leaves, on the rachis or lower leaflet surface, are extremely short, and are evanescent types, which must be distinguished from the permanent type, if possible.

The shapes and measurements of leaflets are, as in all such cases, of importance within certain limits, but there is some variability. A terminal leaflet appears to be present in some leaves, but not in others. A careful examination of the apparent terminal leaflet will often reveal a small stub at its base, such as one finds frequently in *J. nigra* between the two uppermost leaflets; this may be the remains of a true terminal leaflet or of the other member of the uppermost pair of lateral leaflets, only one of which persists.

The color and stoutness of the twig (youngest growth) are undoubtedly of value, but to use these characters would require extensive field studies at different times of year. In almost all members of the Mexican and Central American species the terminal bud appears to be more slender (elongate?) than that of *J. nigra*.

The writer wishes to thank the American Philosophical Society for valuable assistance in collecting material in Mexico. He also wishes to thank the curators of the various herbaria for their generosity in lending specimens and sending photographs; especially Dr. O. Hagerup, Botanisk Museum, Copenhagen, Denmark; Dr. H. Humbert and Dr. J. F. Leroy, Muséum National d'Histoire Naturelle, Paris, France; Dr. M. Martinez and Dr. R. Llamas, Instituto de Biología, Chapultepec, Mexico; Dr. C. Baehni, Conservatoire et Jardin Botaniques, Geneva, Switzerland; Sir Edward Salisbury, Royal Botanic Garden, Kew, England; and Dr. T. E. Hasselrot, Naturhistoriska Riksmuseet, Stockholm, Sweden.

In addition to the native species listed in the key and in the descriptions below, the Persian or English walnut, *J. regia* L., is cultivated in various regions of Latin America. There are no definite records of this species escaping from cultivation. This species has 7-9, entire, essentially glabrous leaflets, elongate, subsessile staminate flowers, glabrate somewhat irregularly dehiscent husk, and rugose nut shell with strong lips.

The following key to the native Mexican and Central American species and varieties of *Juglans* is not absolute, as there are occasional variations in individual features on certain trees or branches; a combination of characters as given in the descriptions must sometimes be used.

1. Mature leaflets about 1–1.5 cm. wide; fruit 1.2–2.2 cm. in diameter; nut 1–1.7 cm. in diameter; plants mostly of shrubby growth (leaflets 17–31, narrowly lanceolate, elongate, curved); nw. Nuevo León, Coahuila, and ne. Chihuahua. 6. *J. microcarpa*.
1. Mature leaflets 2 cm. or more wide; fruit 2.3–5.5 cm. in diameter; nut 2–5 cm. in diameter; trees.
 2. Leaflets 9–15 (fruit not conspicuously verrucose; nut not sharply ridged).
 3. Leaflets and rachis both essentially glabrous (rachis with minute stalked glands visible with a strong lens); leaflets tapering at base; fruit glabrate; nut rather deeply furrowed; Mexico, Guerrero, Jalisco, Michoacan, Durango. 4. *J. major* var. *glabrata*.
 3. Leaflets beneath and rachis both strongly fascicled-hairy or glandular-pubescent; fruit mostly pubescent; nut striate.
 4. Rachis whitish-pubescent; leaflets pubescent beneath with solitary hairs or rarely in part fascicled-hairy, not fascicled-hairy above, tapering at base; terminal leaflet mostly present; nut 1.8–2.8(–3) cm. in diameter; Chihuahua, Sonora, Sinaloa, Durango. 4. *J. major*.
 4. Rachis fascicled-hairy or rarely brownish glandular-pubescent; leaflets fascicled-hairy beneath, and slightly so above, truncate at base, though often oblique; terminal leaflet mostly absent; nut 2.5–4.5 cm. in diameter; Nuevo León, San Luis Potosí, Hidalgo, Tamaulipas, Guanajuato, Puebla. 3. *J. mollis*.
 2. Leaflets on larger leaves (16–)17–31; (fruit in some species conspicuously verrucose with open flat-topped warts; nut deeply furrowed or sharply ridged).
 3. Leaflets truncate at base, essentially sessile.
 4. Leaflets fascicled hairy beneath; nut sharply ridged, blackish; staminate catkins 6–10 cm. long; (leaflets 16–21); Nuevo León. 2. *J. hirsuta*.
 4. Leaflets glabrate, or pubescent beneath with solitary or paired hairs; nut deeply furrowed with flat-topped broad or rarely narrow ridges, dark brown; staminate catkins 18–22 cm. long (unknown in *J. steyermarkii*).
 5. Leaflets (19–)21–31, lanceolate or oblong-lanceolate, glabrate beneath; lateral veins mostly leading directly to sinuses, and then sending a branch to the tooth; husk strongly verrucose with open, flat-topped warts, glabrous; Vera Cruz. 1. *J. pyriformis*.
 5. Leaflets 16–18, ovate, strongly whitish-pubescent beneath; lateral veins mostly leading directly to the teeth; husk not strongly verrucose, pubescent; n. Guatemala. 7. *J. steyermarkii*.
 3. Leaflets strongly tapering at base or decidedly stalked; (fruit strongly verrucose with open warts; leaflets 17–23; staminate catkins (15–) 18–30, the bract on the pedicel).
 4. Leaflets and rachis appearing glabrous (but with strong lens rachis appearing covered with stalked glands); leaflets inconspicuously lepidote, decidedly stalked; Guatemala and Honduras. 6. *J. olanchana*.

4. Leaflets beneath strikingly fascicled-hairy, conspicuously lepidote under the hairs, subsessile; rachis whitish-villous; Colima and w. Jalisco. 6. *J. olanchana* var. *standleyi*.

A list of collections is recorded for each species to validate the distribution. In each state the localities are arranged in general from north to south. Also recorded are the herbaria wherein the specimen may be found. Whenever staminate flowers, pistillate flowers, immature fruit, or mature fruit as well as leaves are present, indication is made by the abbreviations "stam.," "pist.," "im. fr.," or "fr." respectively; "fr. only" indicates that no leaves are present. When the material is sterile no symbol is given. The following are the herbaria and their abbreviations as used in this paper: AA — Arnold Arboretum; AMH — Amherst College; BH — Bailey Hortorium; BPI — fruit collection, Bureau of Plant Industry, U.S.D.A.; CAL — University of California; CM — Chicago Museum of Natural History; CU — Cornell University; GH — Gray Herbarium; ILL — University of Illinois; MICH — University of Michigan; MO — Missouri Botanical Garden; MS — Michigan State College; NC — University of North Carolina; NY — New York Botanical Garden; OKLA — University of Oklahoma; P — Philadelphia Academy of Sciences; REY — H. C. Reynolds; TENN — University of Tennessee; TEX — University of Texas; US — U. S. National Herbarium; USDA — U. S. Department of Agriculture; USFS — U. S. Forest Service; Y — Yale University; WEM — the writer's personal herbarium, Bucknell University; COP — Botanisk Museum, Copenhagen, Denmark; GEN — Conservatoire et Jardin Botaniques, Geneva, Switzerland; HON — Escuela Agricola Panamericana, Tegucigalpa, Honduras; K — Royal Botanic Garden, Kew, England; MEX — Instituto de Biologia, Chapultepec, Mexico; PAR — Muséum National d'Histoire Naturelle, Paris, France; ST — Naturhistoriska Riksmuseet, Botaniska Avdelningen, Stockholm, Sweden.

The vernacular name for all species of *Juglans* throughout Latin America is *nogal*; for small walnuts, such as *J. microcarpa*, as well as for hickories, the name is *nogalillo*. The nut is usually called *nuez*, or *nuez encarcelado*. There are undoubtedly other names, but most of these are not recorded. Martinez (1937) lists alphabetically the vernacular names of plants including walnuts in different states, but there is some uncertainty as to which species they apply.

1. *Juglans pyriformis* Liebm., Vid. Med. Naturh. Copenhagen 1850: 78–80. — Dode, Bull. Soc. Dendrol. France 1909: 198–199. — Standley, Contrib. U. S. Nat. Herb. 23: 165. 1920, pro parte.

Tree tall, deciduous; twigs quite stout, chocolate-brown to gray-brown, conspicuously lenticellate, glandular-pubescent on hairy-leaved plants, soon becoming glabrate, or glabrous or nearly so on glabrate-leaved branches; pith light brown; terminal bud elongate, slender, light brown; lateral buds superposed, brown and glabrate or some of them grayish-pubescent; leaves large, 40–60 cm. long, up to 30 cm. broad, unequally or sometimes equally pinnate; rachis brownish-villous or -pubescent on

some trees, minutely glandular-puberulent or with scattered minute appressed fascicled hairs on others, or even glabrous; leaflets 18–31, alternate, subopposite, or opposite, lanceolate or oblong-lanceolate, the principal ones 10–15 cm. long and 3–4.5 cm. wide (12×3 ; 15×4.5), sessile or subsessile, somewhat cordate to sub-truncate to rounded, rather oblique at the base, tapering to a long-acuminate tip, the margin slightly reflexed-falcate, serrulate, glabrous or apparently so on the upper surface (though on some specimens with minute scattered fascicles of hairs), on the lower surface brownish-pubescent on the main veins on leaves of some trees, on others nearly glabrous or sometimes with many scattered appressed fascicles of hairs on larger and some of the smaller ones; young leaflets densely dark-lepidote, especially on the lower surface, not tomentose, and usually without fascicled hairs, older leaflets inconspicuously lepidote with scattered minute dark glands; staminate catkins 18–22 cm. long (—37 cm. fide Dode), with rather large, distant flowers, the bract small (1 mm.), rounded, only slightly pubescent, at the apex of the pedicel (at base of the receptacle of the flower); stamens 43–58, the anthers glabrous; pistillate flowers unknown; fruit subglobose to pyriform-subglobose, 4.5–5 cm. long, 4.3–4.7 cm. in diameter, nearly glabrous, conspicuously verrucose with large open flat-topped grayish or light-brown warts; nut large, hard, thick-shelled, subglobose to depressed subglobose, compressed, 3.5–4 cm. long and 4×3.5 to 4.5×4 cm. in diameter, strongly longitudinally ridged, the ridges narrow but rounded at top (obtuse, fide Dode) to rather broad and flat, with sharp-angled edges, the furrows rather deep especially at the base of the nut, the whole often resembling a deep striate condition; dorsal partitions high; lacunae large, but otherwise much as in *J. nigra*.

VERNACULAR NAME: *Nogal*, though that name not recognized at Orizaba, where the tree was not well known.

VERA CRUZ: Coscomatepec, Gulf of Coscomatepec, near Mt. Orizaba, *F. Liebmann* 3776 fr. (TYPE-NUMBER — COP, CM, K, GEN). — Coscomatepec, in village, alt. about 4200 ft., *W. E. & M. S. Manning* 53808 fr., 53809, 53810 (WEM). — Orizaba, *Botteri* 879 stam. (K, PAR). — Orizaba, mountain sides near town, *Witmer Stone* 80 (P). — Santa Ana (about 10 miles north of Orizaba), *Borngau* 3032 fr. (PAR). — Trail up Cerro San Cristobal, Orizaba, alt. 4200 to 5000 ft., *W. E. & M. S. Manning* 53736, 53745, 53773 fr., 53794, 53796, 53799 (WEM). — Cultivated in Alamda, Orizaba, *W. E. & M. S. Manning* 53788 fr. (WEM). — East of San Andres Tuxtla, nw. of Catemaco, near Cerro Tapalcapan & C. Mastagaga, tropical evergreen forest, *Dressler & Q. Jones*, in 1953, nut only (WEM).

This species, the first to be described for Mexico, and the most distinctive, has not been well understood in the New World. This is probably because so few specimens have been collected — none between 1890 and 1953 — and because no specimens existed in the American herbaria until very recently. The description of Standley (1920) does not clearly indicate this species, as he lists a different number of leaflets and combines the features of various taxa. The writer fully understood the species

only when he had collected from trees in the Orizaba and Coscomatepec region 112 years after Liebmann was there.

Liebmann clearly distinguished this species from *J. nigra*. *Juglans pyriformis* has more numerous, narrower, more finely serrate, less hairy leaflets and lighter colored, less sharply ridged nuts with more prominently verrucose husks. The internal structure of the nut is not distinctive, though Liebmann thought that the lacunae were larger. Dode (1909) also stressed the surface of the nut.

This species differs from all other Mexican species in the larger number of narrow leaflets and in its conspicuously verrucose husk, though there is some overlapping in the number of leaflets. The staminate catkins are longer than those found in all other species except *J. olanchana* var. *standleyi*. The large nut is typically more deeply grooved than that of *J. mollis* and *J. major*. In the type-collection of *J. pyriformis* the narrow, rounded ridges approach those of *J. hirsuta*; the nut of the latter species has a few or several broad ridges, but there are always more of the narrow, sharp, broken ridges present in the darker nut. In general, the features appear to combine features found in *J. hirsuta*, *J. mollis*, and *J. major* var. *glabrata*, with the differences noted above. Discussion of the relationship between *J. pyriformis* and the Central American species will be found under *J. olanchana*.

There is a variation in the hairiness of the rachis which is quite striking, and the writer at first thought that the two conditions represented two different species. The trees at Coscomatepec, as far as collected, have brown-villous rachises; some of the trees near Orizaba have villous rachises, while others have glabrous rachises; all have nearly identical shapes of leaflets and nearly identical fruits where collected.

It is surprising that this species appears to grow in such a limited area: within a range of less than 125 miles. Part of this seemingly limited range is due to a lack of collecting. Until the collection of Dressler and Jones in 1953 the range had been 40 miles. The species is so closely related to *J. olanchana* of Guatemala and Honduras that it must occur somewhere in the mountains of the isthmus of Tehuantepec and northwest, an area not well known botanically. It is significant that *Engelhardtia mexicana*, a member of the Juglandaceae which occurs with *Juglans pyriformis* on the same slope of Cerro San Cristobal close to Orizaba (see Miranda, 1946, where he at first considered *E. orizabensis* a distinct species), has been collected by Dr. A. J. Sharp and Dr. E. Hernandez X. on the isthmus northeast of Juchitan and north of Niltpec, on the divide of the Sierra del Sur near the headwaters of the Rio Coatzacoalcos.

2. *Juglans hirsuta* Manning, sp. nov.* (Amer. Jour. Bot. 35: 616. 1948, nomen subnudum).

* *Juglans hirsuta* Manning, sp. nov. Ramuli glanduloso-pubescentes; gemmis terminalibus gracilibus; foliis paripinnatis; rhachi valde rufescente-glanduloso-hirsuta; foliolis 16-22, 2.5-6 cm. latis, ovato-lanceolatis, sessilibus, basi truncatis venis supra glanduloso-pubescentibus, subtus pilis plerumque fasciculatis; fructibus 3-4.7 cm. dia.

Juglans mexicana sensu Sargent, Trees and Shrubs 1: 1-2, *pl.* 1. 1902, pro parte.

Juglans mollis sensu Dode, Bull. Soc. Dendrol. France 1909: 197, pro parte.
— sensu Standley, Contrib. U. S. Nat. Herb. 23: 165. 1920, pro parte.

Large, rather spreading deciduous tree; young twigs reddish brown, glandular-pubescent or -hirsute, sometimes partly fascicled-hairy, becoming gray-brown the second season; pith light brown; terminal bud slender, elongate, grayish-tomentose; leaves large, equally or sometimes unequally pinnately compound, true terminal leaflet usually absent; rachis strongly glandular-villous or hirsute, the hairs brown, with a few scattered fascicled hairs, the latter more prominent on younger leaves; leaflets mostly 16-21, rarely 14-23, opposite or subopposite, sometimes alternate, medium, rather thick, somewhat rugose, ovate to ovate-lanceolate to oblong-lanceolate, 2.5-6 cm. wide and up to 15 cm. long, the apex abruptly long-acuminate, the margin finely to coarsely serrate, the teeth often incurved, somewhat blunt, the lateral veins mostly leading directly to the sinuses and then sending a branch to the tooth; the middle leaflets sessile or nearly so, truncate to rounded at the base, commonly oblique, the upper surface commonly glandular-pubescent on the principal veins or over the whole surface, not fascicled-hairy, sometimes becoming glabrate, the lower surface inconspicuously lepidote, strongly tomentose with whitish fascicled hairs mixed with brown glandular hairs and with solitary and paired sharp-pointed whitish hairs (on surface and veins), the midrib and frequently the strong lateral veins densely brownish glandular-hairy; staminate catkins 6-10 cm. long, the flowers not especially crowded, with short (1-1.5 mm. long) ovate-lanceolate whitish-tomentose bract located on the back of the flower, the perianth consisting of the bract, 2 bracteoles, and 4 or sometimes 6 sepals; stamens 20-34; pistillate flowers few, tomentose with frequent to numerous glandular hairs appearing through the fascicled ones; fruit medium to large, 3-4.7 cm. in diameter, globose to somewhat pyriform-subglobose or oval, strongly glandular-pubescent or villous, especially when young, not conspicuously verrucose-punctate because of hairs but at complete maturity very finely and densely minutely verrucose, not so prominently so as in *J. nigra*; nut dark reddish brown or mostly blackish, somewhat compressed, about as high as broad, (2.5-)3-4 cm. in diameter with numerous interlacing irregular flat-topped to rather narrow-topped ridges or frequently a mixture of the two, the furrows rather deep, in general appearing sharp-ridged, and strongly resembling the nut of *J. nigra*; dorsal partition rather high; secondary wall cavities prominent, varying from 4-8 at different levels, as in *J. nigra*, the primary wall cavities absent.

VERNACULAR NAMES: *nogal*, *nogal encarcelado*.

NUEVO LEON: Potrero, Alamo, 5 miles south of Villaldama, at mouth of canyon and in narrow canyon in the mountain along stream with *Platanus*, *W. E. & M. S. Manning* 53354 fr., 53358 fr., 53359 fr., 53366 fr., 53368 fr., 53369 fr., metro, glanduloso-pubescentibus; nuce subfusca, 3-4 cm. diametro, extus rugosissima, rugis asperatis etiam subplanis.

53370 fr., 53371 fr., 53372 fr. (WEM). — Monterrey, canyons in Sierra Madre above city, alt. 2500 ft., *Canby, Sargent & Trelease* 223 or 123a stam., pist., fr. (AA, K, MO, US); *Pringle* 10214 stam. (CAL, CM, COP, CU, GH, K, MEX, MO, MS, NY, P, ST, US); *Pringle* 10374 fr. (TYPE-US; ISOTYPES-GH, MICH, Y); *Sargent*, in 1887, pist. (AA); unknown collector 18, "*nogal encarcelado*", fr. (P). — Monterrey, Sierra de la Silla, alt. 1700 ft., *Pringle* 11178 fr. (CM, GH, K, MO, NY, US). — Monterrey, Canon Diente in Sierra Madre, *C. H. & M. T. Muller* 63 fr. (AA, CM). — 3 miles west of Monterrey, Chipinque Mesa, base, alt. about 2000 ft., *W. E. & M. S. Manning* 53336 fr. (WEM); same general locality, base to half way up to mesa, alt. 2000 to 3000 ft., *W. E. & M. S. Manning* 53347, 53341 (WEM). — 3 miles west of El Cercado (which is 2 miles south of Villa Santiago, 25 miles south of Monterrey), Hacienda Vista Hermosa, Horsetail Falls (Cola de Caballo), alt. about 2500 ft., *W. E. & M. S. Manning* 53129a fr., 53129b fr. only, 53131 fr., 53132a, 53132b, 53132c, 53132d, 53132e all fr. only (WEM); *A. Dyck*, Nov. 1954, fr. only (WEM); *Rowell & Barkley* 16MS65 (TEX); *White* 1633 (MICH); above Horsetail Falls, alt. 3000 to 4000 ft., *W. E. & M. S. Manning* 53171a fr., 53171b fr. only (WEM). — Road from Linares to Galeana, along stream near base of canyon, alt. about 2000 ft., *W. E. & M. S. Manning* 53187 (WEM).

Juglans hirsuta has been confused by various authors with *J. pyriformis*, *J. mollis* and *J. mexicana*, and yet it is probably more closely related to a very different species. The writer, at first confusing the Monterrey specimens collected by several botanists with *J. pyriformis*, and then with *J. mollis*, next decided that some of the specimens collected in the Jacala region of Hidalgo were conspecific with specimens from Monterrey because of the glandular-pubescent leaf rachises and fascicled-hairy lower leaflet-surfaces, though the nuts, where available, seemed somewhat different. Field studies by the writer of trees south of Monterrey, south of Galeana, and south of Jacala, showed at once that the nuts at Monterrey were quite different from those in the other regions. But abundant mature nuts of the Monterrey trees were not available until the fall of 1954 when, at the request of the writer, Miss Annabelle Dyck, of Monterrey, secured material from Horsetail Falls and sent it to the writer. These mature nuts are black, sharply ridged, and practically identical with those of *J. nigra*, although a few broad ridges are present on many of the nuts (this condition occasionally occurs on certain trees of *J. nigra*). It is possible that *J. hirsuta* may be a hybrid offspring of *J. nigra* and *J. mollis*, the ranges of which no longer overlap. Specimens collected by the writer at Potrero have small nuts similar to those of *J. hirsuta*, but the hairs on the rachises of the leaves of several of the trees are not as brown, and the fascicled hairs on the lower surfaces of the leaflets are rare. These trees, the leaves of which at first looked like those of *J. major*, are considered as variants of *J. hirsuta*, but they are similar to the small-fruited *J. nigra* of southern Texas. The features separating *J. hirsuta* from *J. nigra* are primarily vegetative ones: the striking brown-glandular hirsute leaf rachises, the fascicled hairs underneath the leaflets, the more nearly truncate leaflet-bases, the more slender terminal buds, and the less definitely verrucose husks of the fruits. The writer recognizes *J. hirsuta* until further studies

can be made in Texas and Nuevo León to settle the relationship between the two taxa.

The sharply ridged nuts of *J. hirsuta* are different from those of all other species of Mexico and Central America, although immature nuts are confusing. Some of the nuts of *J. pyriformis* have, however, rather narrow ridges with rounded tops. The leaves are typically different from those of *J. mollis*, averaging more numerous leaflets and having villous instead of fascicled-hairy rachises with many of the pointed hairs beneath the leaflets solitary or paired instead of mostly in fascicles. However, the rachises of the leaves of certain specimens of *J. mollis*, especially those from near Jacala, Hidalgo, have glandular hairs, as in *J. hirsuta*, and these hairs are only slightly shorter than those of *J. hirsuta*. Leaflets of *J. hirsuta* do not seem to have fascicled hairs on the upper surface such as are found in *J. mollis*; the constancy of this feature will have to be studied (see note under *J. mollis*).

The distinctions between *J. hirsuta* and *J. pyriformis* have been discussed under the latter species. *Pringle 11178* has leaves which closely resemble those of *J. pyriformis* in shape of leaflets, but the leaflets are fascicled-hairy beneath, the husk is not strongly verrucose, and the nut is the smallest of all of the collections of *J. hirsuta*, hence much smaller than in *J. pyriformis*.

Some Mexicans told the writer that the nuts of *J. hirsuta* are not used as food by the natives. Farmers above Horsetail Falls, however, stated that the nuts are occasionally used. The trees are local, the nuts are hard to crack, and so the use as food is not significant. Good varieties of *J. nigra*, however, would probably grow where *J. hirsuta* is native. Whether these trees could compete under cultivation with the pecan, which, incidentally, was planted as an orchard tree in the exact region under discussion, is questionable.

3. *Juglans mollis* Engelm. in Hemsley, *Diagnoses plantarum novarum vel minus cognitarum mexicanarum et centrali-americanum*. Pars 3: 54. 1880. — Dode, *Bull. Soc. Dendrol. France* 1909: 197, pro parte. — Standley, *Contrib. U. S. Nat. Herb.* 23: 165. 1920, pro parte.

Juglans mexicana S. Watson, *Proc. Amer. Acad. Arts and Sciences* 26: 152. 1891. — Sargent, *Trees and Shrubs* 1: 1, *pl. 1*. 1902, pro parte.

Medium-sized tree; young twigs densely fascicled-pubescent or partly brown-glandular pubescent, very rarely brown glandular-pubescent, becoming glabrate, mostly dark brown, the second year's growth gray-brown with scattered prominent lenticels; terminal bud slender, brown- or gray-tomentose; pith light brown; leaves alternate, equally or sometimes unequally pinnately compound, terminal leaflet, when present, with stub of other leaflet at its base; rachis, usually tomentose with numerous persistent spreading fascicled hairs, especially beneath, in rare cases becoming glabrate or, in trees of some regions, densely pubescent with short brown glandular hairs, the fascicled hairs few; leaflets 10–14, rarely 8–16, opposite or alternate, sessile or subsessile, broadly ovate to ovate, occasionally

ovate-lanceolate or elliptical-lanceolate, the larger ones 6×3 , 8×3.5 , 8.5×4 , 10×4 or 15×5 cm. long and wide, truncate to rounded at the base, but frequently oblique, rather abruptly long-acuminate at the apex or tapering from the middle to the apex, finely or coarsely serrate, the upper surface glabrate, with minute appressed fascicled hairs along the midrib and principal side veins, lepidote on the lower surface with rather prominent golden glands and tomentose on the midrib, veins, and surface proper with fascicles of spreading hairs, each fascicle with a short yellowish glandular stalk, solitary pointed hairs apparently rare, the midrib fascicled-hairy or rarely in part brown-glandular pubescent; staminate catkins 8–10 (rarely 10–16, in *Salazar*) cm. long, slender, the flowers rather small, the individual floral bracts small, whitish tomentose, on the backs of the flowers; stamens 25–30 (rarely 87, in *Salazar*); pistillate flowers few, densely tomentose; fruit globose to subglobose, sometimes pyriform, the husk 3–4 (–8?) mm. thick, at first usually covered with fascicled hairs, but in some cases with short brown-glandular hairs, becoming glabrate, usually very inconspicuously verrucose, 3–5 cm. in diameter, 3.5–5 (–6, fide Sargent?) cm. long; nut globose to subglobose, somewhat compressed, 2.5–4.5 cm. in diameter, 2.8–4 cm. long, reddish brown, shallowly to deeply striate, that is, with broad flat to rounded longitudinal ridges, the grooves rather shallow, but strong, occasionally forked and interlacing, the nut very rarely with dorsal “lips” or “wings”; dorsal partition “rather low” to rather high; lacunae 8–4, depending upon the level, not especially large, the primary wall lacunae mostly absent, but present or indicated by dark areas in some of the larger nuts.

VERNACULAR NAMES: *nogal*; *nogal encarcelado*; *nuez meca* (fide Martinez).

NUEVO LEÓN: 3 miles west of Monterrey, near top of Chipinque Mesa, alt. about 4000 ft., *W. E. & M. S. Manning 53344, 53345* (WEM).—West of Galeana, at foot of Cerro Potosí, in arroyo near Ojo de Agua, alt. 5800 ft., *A. J. Sharp 45675* (TENN).—15 mi. sw. of Galeana, Sierra Madre Oriental, *C. H. & M. T. Muller 428* stam., pist. (AA, CM, MEX, MICH, NY, US).—15 mi. sw. of Galeana, Mesa de la Camisa, *C. H. & M. T. Muller 1156* im. fr. (AA, CM, MEX, MICH, NY, US).—near Tarey (e. of Pablillo, which is 20 mi. s. of Galeana), rainy area or fog belt, alt. about 7200 ft., *W. E. & M. S. Manning 53244, 53250* fr., *53268, 53331* (WEM).—Dulce Nombres and into Tamaulipas, just east of border, 24° N., 99.5° – 100.5° W, Sierra Madre Oriental, *Meyer & Rogers 2642* im. fr. (MO, WEM). TAMAULIPAS: above Gomez Frias, Cerro del Tigre, Rancho del Cielo, alt. 1200m., *Sharp, Hernandez, Crum & Fox 50246* (NC, TENN, WEM).—SAN LUIS POTOSÍ: Mineral de Guadalcázar. *M. Villada* in 1892 (MEX).—Villar (40 mi, ne. of San Luis Potosí), alt. 5000 ft., *J. Graber 219* fr. (US).—San Luis Potosí (or Alvarez?, see *Carya illinoensis*, *Parry & Palmer 835 1/2*), *Parry & Palmer 835* fr. (TYPE-K; ISOTYPES-GH, MO, P, US).—*Alvarez, Palmer 68* fr. (AA, CM, GH, MEX, MO, NY, US, BPI, USDA).—San Jose Pass (near Villar?), *Pringle 3322* fr. (TYPE of *J. mexicana* Engelm.) (AA, AMH, CAL, CM, GH, MEX, MO, MS, NY, US, Y, GEN, K, BPI).—Minas de San Rafael, Sierra Tablon (near Cerritos?), *Purpus 5502* im. fr. (CAL, CM, GH, NY, US).—16–18 mi. by road e. of Ciudad del Maiz, oak forest, alt. 3800 ft.,

W. E. & M. S. Manning 53424, 53432 fr., 53426 (WEM).—23 m. e. of Ciudad del Maiz, oak forest, alt. 2200 ft., *W. E. & M. S. Manning* 53440 (WEM).—4 mi. w. of Pendencia (about 10 mi. ne. of Ciudad del Maiz), alt. 4600 ft., *Graber* 206 fr. (US). GUANAJUATO: Palmillas, Río Palmillas, 25 km. ne. of San Luis de La Paz, *Little* 11093 (USFS, WEM). HIDALGO: n. of Jacala, *Clark* 7029 (OKLA).—6–10 mi. n. of Jacala, alt. 4900–5400 ft., *W. E. & M. S. Manning* 53582 fr., 53594 fr., 53595 fr., 53600 (WEM).—Jacala, alt. 4400 ft. *Chase* 7624 fr. (CM, GH, ILL, MO, NY, USDA); *Lyonnel* 1304 fr. (US).—6–7 mi. s. of Jacala, Sierra Madre Oriental, alt. 5000–5400 ft., *Reynolds* 6826 fr. (REY, WEM); *W. E. & M. S. Manning* 53641, 53643 fr., 53645, 53646, 53647 fr., 53648 fr. (WEM).—13 mi. s. of Jacala, alt. 6200 ft., *W. E. & M. S. Manning* 53636 (WEM).—SW. of Jacala on road to Zimapán, district Jacala, alt. 1500 m., *Moore & Wood* 3946 fr. (BH, WEM).—La Majada, on route 1, 229 or 222 km. n. of Mexico City (about 20–29 mi. s. of Jacala), alt. 6400 ft., *Sharp, Hernandez X., Crum & Fox* 5020 (NC, TENN, WEM); *W. E. & M. S. Manning* 53623, 53624 (WEM).—Between Zacualtipán and Olatla, Río Panotlán, on road to Metztitlán, alt. 1600–2000 m., *Moore* 5328 fr. (BH, CAL, WEM), 3241 im. fr. (BH, GH), 2386 stam. (BH, GH).—NE. of Molango, slopes below Chalma on trail from Molango to Calnali, *Moore* 3013 im. fr. (BH, GH).—Sierra de la Mesa (probably w. of Ixmiquilpan), *Rose, Painter & Rose* 9095 fr. (GH, NY, US). PUEBLA: Zacapoaxtla, *J. Salazar*, in 1913, stam. (MEX, US).

This species has a wide distribution and has been well known in Mexico ever since it was first described. It is difficult to separate it sharply from some of the other species. *Juglans mollis* differs from *J. pyriformis* in having fewer, broader, more fascicled-hairy leaflets, shorter staminate catkins, less verrucose husk and less deeply grooved nuts. Vegetatively, trees of this species in certain regions are similar to *J. hirsuta*, as discussed under that species and below, but the nuts are different. The nuts of *J. mollis* are rather similar in external markings to those of *J. pyriformis*, *J. major*, and *J. olanchana* var. *standleyi*, though there are differences in size and depth of grooves. Because of the extent of variation no single feature will hold throughout but two or more must be used in combination. The distinctions in nuts and vegetative features are discussed under the other species and are given in part in the key to the species.

The fascicled-hairy lower surface of the leaflets is rather constant in the species. The rachises found on the type-specimen are strongly fascicled-hairy, and are similarly hairy on many specimens. In southern Nuevo León and in Hidalgo the rachises on some of the trees are strongly glandular-pubescent as in *J. hirsuta* and, as discussed under that species, it is difficult to distinguish the two species except where fruiting.

The rather moldy specimen collected on the Mesa de la Camissa, 15 miles southwest of Galeana (*Muller* 1156), called *J. mollis* by the writer largely because of its range, resembles *J. major* var. *glabrata* in being much less hairy throughout (leaflets, rachis, fruit) and having essentially tapering leaflet bases but probably represents an aberrant collection from abnormal branches of *J. mollis*; mature fruit is lacking.

The original description of *J. mexicana* by Engelmann—"foliage as in *J. nigra*, but with the pubescence of *J. cinerea*—," i.e., with glandular-

villous rachis and fascicled-hairy lower leaflet-surface, suggests *J. hirsuta*, not *J. mollis*. However, although the specimens of *Pringle 3322* (the type-collection of *J. mexicana*) in some herbaria have glandular-pubescent rachises, such as occur in *J. hirsuta* (also in *J. cinerea* and *J. nigra*), specimens in some other herbaria have fascicled-hairy rachises, and in others glabrate ones. The nut is clearly that of *J. mollis*, not *J. hirsuta*, though the lips on the nut are unusual for any species. This collection is the one illustrated by Dode for *J. mollis* (1909, p. 175). Sargent (1902), in his description and excellent illustration of *J. mexicana*, combines collections of *J. hirsuta* and *J. mollis*; in general, the flowers are *J. hirsuta* (*Pringle 10214*, Sargent), and the fruit is *J. mollis* (*Pringle 3322*); the figure of the leaves with the unusual leaflet-bases was made from an atypical specimen of *Pringle 3322*.

Two collections by the writer (53250 and 53645), presumably variants of *J. mollis* because all other trees in the region are that species, do not have fascicled hairs on the upper surfaces of the leaflets.

A collection of nuts at the Arnold Arboretum, marked *J. mexicana*, presumably sent by Newton Pierce, of U.S.D.A., who was stationed in California, are *J. mollis*, though two nuts do not belong to that species and may have been mixed in the herbarium from a collection from Colombia. Unfortunately the source in Mexico is not given.

The writer has not recorded *J. mollis* from Durango. However, certain specimens called by the writer *J. major* forma *stellata*, especially *Palmer 448* and *476*, appear similar to *J. mollis* in leaflet-base and hairiness; the rachis is glandular-pubescent as in *J. major* or certain trees of *J. mollis*. The nut is smaller than in *J. mollis*, and has surface markings closer to *J. major*. The trees of this region need further study.

Juglans mollis and *J. hirsuta* both grow in Nuevo León, but not together. The latter appears to grow at lower elevations (or possibly in different habitats: stream valleys instead of mountain fog belts). Thus at Chipinque Mesa, near Monterrey, *J. hirsuta* grows at the foot of the mesa at about 1800' ft. elevation and *J. mollis*, several miles away by winding road, grows near the top of the mesa at about 4000 ft. elevation, at the most northerly point in the range of the species. Unfortunately the trees of the latter collected by the writer were not fruiting, and the identification is not positive. A similar situation occurs with respect to the Linares (*J. hirsuta*) and Pablillo (*J. mollis*) collections.

4. *Juglans major* (Torr.) Heller, *Muhlenbergia* 1: 50. 1900. — Standley, *Contrib. U. S. Nat. Herb.* 23: 165. 1920. — Johnston, *Jour. Arnold Arb.* 25: 436. 1944.

Juglans rupestris Engelm. ex Torr. β *major* Torr. in Sitgreaves, *Rep. Zuni & Colo.* 171, *pl.* 16. 1853. — Sudworth, *Poplars, Principal Tree Willows and Walnuts of the Rocky Mountain Region*, U.S.D.A. Tech. Bul. 420: 102. 1934.

Juglans elaeopyren Dode, *Bull. de l'Herb. Boissier*, II. 7: 247-284, *figs.* 1-3. 1907.

Juglans neomexicana Dode, Bull. Soc. Dendrol. France 1909: 191. 1909.

Juglans arizonica Dode, loc. cit. 193.

Juglans torreyi Dode, loc. cit. 195.

Juglans microcarpa Berl. var. *major* (Torr.) Benson in Benson & Darrow, Trees and Shrubs of Southwestern Deserts, ed. 2, 110. 1954.

Small or large tree, sometimes with several trunks; young twigs light to dark brown, finely whitish glandular-pubescent or -puberulent, the second year's growth slender, usually ashy gray or sometimes yellowish brown, with rather prominent lenticels; terminal bud slender; leaves unequally or sometimes equally pinnately compound, the terminal leaflet usually present; rachis usually finely whitish glandular-pubescent, rarely glabrate, very rarely (on special branches: young growth?) glabrous; leaflets 9–15, rarely to 17, opposite or alternate, subsessile or short-stalked, oblong-lanceolate to ovate, the larger ones usually 2–3.4 cm. wide (or rarely 1.5–1.9 cm.), and 6–11.5 (rarely –13) cm. long, typically tapering at the base, characteristically oblique, acuminate at the apex, commonly tapering from the middle of the leaflet to the apex, definitely serrate, but varying from finely to coarsely serrate; youngest leaflets mostly glandular-puberulent, very rarely fascicled-hairy, the mature ones usually lightly puberulent above and densely whitish glandular-pubescent beneath as well as densely golden-glandular (lepidote), varying to partly fascicled-hairy (forma *stellata* below), very rarely glabrate; staminate catkins 7–17 cm. long, slender, the individual floral bracts small, whitish-tomentose, on the backs of the flowers; sepals, in addition to the bract and two bracteoles, 4–8; stamens 30–50; pistillate flowers solitary or few, glandular-pubescent; fruit globose to rather oval, the husk rather thin, finely glandular-pubescent, inconspicuously verrucose, usually 2.3–3 (rarely 1.9) cm. in diameter; nut 1.8–2.8 cm. in diameter, subglobose, slightly compressed, longitudinally striate, sometimes rather deeply so; dorsal partition varying from low to rather high, the lacunae 8–4, depending upon the level, typically well developed for the size of the nut, rarely reduced to barely more than a canal.

VERNACULAR NAMES: *nogal*; *nogal silvestre*.

SONORA: 5 mi. s. of Naco, San Jose Mts., alt. 6000 ft., *Wolf 2518* fr. (GH); *Mearns 1049* (NY).—Matiti (or Mababi, 10 mi. sw. of Fronteras), *Thurber 409* fr. (GH, NY).—9 mi. e. of Imuris in canyon of Magdalena river, alt. 3100 ft., *Ferris 8778* stam., fr. (MICH, US).—NE. of Colonia Morelos, Cañon de la Mescalera, Sierra de la Caballera, alt. 4900 ft., *White 4704* (GH, NY).—Colonia Oaxaca (about 25 mi. n. of Bavispe, on Rio Bavispe), *White 464* (GH, MICH).—La Angostura, Cañon de los Otates, *White 3527* (GH, MICH, USDA).—NW. of Bavispe, Cañon International, *White 3496* (GH, MICH, USDA).—W. of Bavispe, Cañon de Bavispe, *White 2994* (GH, MICH, USDA).—Bavispe, Cañon de los Metates, *White 2824* (GH, MICH).—Bavispe, Rio Bavispe, *White 2875* fr. (GH, MICH).—Santa Rosa Cañon (between Bavispe and S. Miguelito), *White 499* (MICH).—W. of Magdalena, Agua Nuevo Arroya, El Alamo, *Kennedy 7040* fr. (CAL, CM, US).—Horconcitos, Rio Huachinera, n. of Huachinera, *White 2971* (GH, MICH, USDA).—La Chumata (a mine, e. of Sierra de San Antonio, probably in the vicinity of Banamichi), alt. 3400 ft., *Brown*, in 1905 (AA).—Between Granados and Bacadehuachi, Aguaje de

Bacatejaca, *White* 2925 (GH, MICH). — Curohui, Río Mayo, *Gentry* 3642 im. fr. (CM). CHIHUAHUA: Municipio de Janos, Carretas, border of Chihuahua and Sonora, alt. 4800 ft., *White* 2616 (GH, MICH, USDA). — Casas Grandes, *Goldman* 427 im. fr. (GH, US). — St. Diego, *Hartman* 588 stam. (AA, GH, K, P). — W. of Chihuahua, mouth of Majalca Cañon, *Le Sueur* 448 fr. (CAL, CM); *Le Sueur*, in June 1936, fr. (GH). — Chihuahua, alt. 1300 m., *Palmer* 141 stam., pist., fr. (GH, K, MO, NY, ST). — Chihuahua, canyon near city, *Pringle* 1596 stam., pist. (CAL, K, MEX, MS). — 7.5 mi. e. of Victoria, road from Jaco to Mestenas, *Stewart & Johnston* 1999 fr. (GH). SINALOA: Quebrado de Platano, Sierra Monterrey, deep moist canyon in oak forest, alt. 3000 ft., *Gentry* 5908 (USDA). DURANGO: Nombre de Dios, alt. 6500 ft., *W. E. & M. S. Manning* 531291, 531293, 531294, 531296 fr., 531297 (WEM).

Sargent (1933) described the staminate catkins as 20–25 cm. (8–10 inches) long; the writer has examined specimens from Mexico and the United States and finds that the catkins are 7–17 cm. long as given in the description above.

Dode (1909, pp. 191–195) in his descriptions of *J. arizonica*, *J. neo-mexicana*, *J. elaeopyren*, and *J. torreyi* gave the number of leaflets as 8–24, 8–20, and 10–20, numbers intermediate between *J. major* and *J. microcarpa*. Studies by the writer of the isotypes of these species in the American herbaria show that the number of leaflets is 11–13 in *J. neo-mexicana* and *J. elaeopyren*. Isotypes of *J. arizonica* so far have not been located in the United States but most specimens of *J. major* from Arizona have 15 or fewer leaflets. *Juglans torreyi* is based on plants cultivated in France. It should also be noted that all fruits located of the isotypes of Dode's species have only immature fruits, and it is difficult to see how Dode could have described the structure of the nuts from specimens such as these.

Dode discarded the name *Juglans major* (Torr.) Heller, because in the description of the species Heller included both *J. rupestris* var. *major* Torr. and *J. californica* S. Wats. The name *J. major* (Torr.) Heller is, however, based definitely on *J. rupestris* β *major* Torr. which in turn is based on material from Arizona and New Mexico. Hence, the name *J. major* should be retained.

The writer is dividing *J. major* into two main races, the northern race being the well known typical taxon, ranging from Arizona and New Mexico to Sinaloa and Durango, and a southern race, the variety *glabrata* described below with larger, glabrate leaves and larger fruits.

The detailed description given above is for the typical species, based upon Mexican specimens, and the deviations within this taxon, considerable in extent, will be discussed first.

At the beginning should be mentioned the variation in hairiness on the lower surfaces of the leaflets. This is sufficient to make the basis for the description of a new form:

4a. *Juglans major* forma *stellata* Manning, forma nova.*

* A *J. majore* differt foliolis subtus pilis saepe fasciculatis.

A plant differing from the species in having many of the hairs on the lower surfaces of the leaflets fascicled, so that these surfaces appear somewhat tomentose. The leaflets of this form are more frequently subtruncate at the base than in the species proper.

Several sheets of specimens intermediate between the species and forma *stellata*, with a few fascicled hairs, are listed under *J. major* itself.

This form approaches *J. mollis* somewhat in leaflet structure, but the leaflets are usually smaller, the fascicled hairs usually shorter, the short, glandular hairs on the lower leaflet-surface more common, the hairs on the rachis usually paler and typically not fascicled, and the fruit and nut smaller. The leaves of this form are similar in some ways to those of *J. hirsuta*.

SONORA: 1 mi. w. of El Tigre, La Matancita, alt. 4250 ft., *White* 4161 (GH, MICH).—8 mi. from Cucurpe, fork of road to El Tigre, *Wiggins* 7161 fr. (AA, US). CHIHUAHUA: 3 mi. w. Ciudad Camargo, alt. 4000 ft., *White* 2284 fr. (GH, MEX, MICH, USDA).—Beyond village of Cocomorachic, Río Papagochic, District Guerrero, *Mexia* 2633 im. fr. (TYPE-AA; ISOTYPES-CAL, CM, GEN, GH, K, MICH, NY, P, ST). DURANGO: Tejamen (s. of Santiago Papasquiario), *Palmer* 476 fr. (CAL, CM, COP, GH, MO, NY, US).—Santiago Papasquiario, *Palmer* 448 fr. (AA, CAL, CM, COP, K, NY, ST, US); *Nelson* 4670 (GH, US).

In addition to the deviation described above there are other critical variations in rachis, leaflets, and fruit in the typical species.

The rachises on a very few specimens are glabrate or nearly glabrous, instead of pubescent. It is significant that in *White* 2616 and 3527 the rachises and the leaflets are essentially glabrous in specimens in some herbaria, strongly pubescent in specimens of the same number in other herbaria.

The leaflet is usually very short-stalked, and oblique with tapering base, but sometimes the stalk is well developed, and sometimes the bases appear almost truncate above an extremely short stalk (leaflet sessile) or above a well developed stalk. The teeth are definite but range from coarse to rather fine, though the leaflets are never revolute along the margin as *J. microcarpa*. The larger leaflets in *White* 3496, *Thurber* 409, *Kennedy* 7040, *Stewart & Johnston* 1999, *Le Sueur* in June 1936, are small and narrow, 1.5–1.9 cm. in width on the specimens observed by the writer.

The number of leaflets in Mexican collections appears to be rather constant, 9–15, rarely 17. For this reason *J. major* var. *stewartii* Johnston has been transferred to *J. microcarpa*, as discussed under that species.

In the shape of the fruit and nut (subglobose) and the lacunae of the nut (well developed), the Mexican collections appear to be rather constant where fruit is present but, since *J. elaeopyren* Dode with oval fruit and nuts has been described from Arizona, one may expect this variation from Mexico (see also *J. major* var. *glabrata* below). Dode describes the lacunae of the nut of *J. arizonica* (nuts not located by the writer) as

reduced to a canal, as in *J. microcarpa*, an unusual condition for *J. major* if fully substantiated.

The size of the fruit and nut varies within rather broad limits. Thus *Palmer 448, 476, Mearns 1049, Wolf 2518, and Stewart & Johnston 1999* have fruits less than 2.2 cm. in diameter, with nuts 1.5–1.9 cm. in diameter. Some of these collections, especially the first two, have fruits of two sizes, indicating the possibility that some of the small fruits might represent abnormal collections or immature fruits. *Stewart & Johnston 1999* is listed by Johnston (1944) under *J. microcarpa*, and although the leaflets are rather long drawn out and the bases not clearly oblique, the leaflets are 14(16?) in number. The extreme on the larger size of fruit in the northern race is represented by a collection by *C. R. Biederman* from Garces, Arizona, found in the fruit collection of Arnold Arboretum. The nuts are 3.1 cm. in diameter.

In general, in the typical *Juglans major* the leaflets are 9–15, relatively narrow, whitish-pubescent beneath, as is the rachis; the nuts are relatively small (but larger than in *J. microcarpa*), striate or longitudinally ridged, with rather large lacunae as seen in cross-section of the nut.

From southern Durango to Guerrero there are trees present in scattered localities in the mountains similar to the northern race of *J. major* in having 11–15 leaflets, these short-stalked, lanceolate to ovate-lanceolate, with tapering leaflet-bases, and staminate catkins 8–16 cm. long, but differing in certain important features. This taxon, the southern race of the species, is here described as a new variety:

4b. *Juglans major* (Torr.) Heller var. *glabrata* Manning, var. nov.*

Juglans pyriformis Liebm. sensu Standley, Contrib. U. S. Nat. Herb. 23: 165. 1920, pro parte.

Juglans glabrata Manning, Amer. Jour. Bot. 35: 616. 1948, nomen subnudum.

Trees of this variety differ from typical *J. major* in having the leaflets and leaves commonly larger, the twig, the rachis and the leaflets appearing glabrous, the stamens 60–75, the fruit and nut larger, and the pith frequently not chambered.

Leaves 30–45 cm. long, and up to 25 cm. wide, the rachis appearing glabrous, but under a strong lens minutely and densely puberulent with extremely short-stalked brown glands, and with scattered evanescent small appressed fascicled hairs in addition to the typical sessile yellow glands, rarely completely glabrous; leaflets 2.3–3.4 cm. wide, 8–11.5 cm. long, occasionally 5.5×15 cm., the margin finely serrate, the lateral veins 13–22 pairs, some of them ending in the teeth, the youngest leaflets (1 cm. wide) drying dark, the lower surface grayish tomentose, soon becoming glabrate, the older leaflets with scattered, minute, brown, appressed, evanescent fascicled hairs (appearing to the naked eye as pin-points) on the largest veins, appearing glabrous except under a very

* *A J. majore* differt foliis et foliis plerumque majoribus, rhachi et foliis glabris, staminibus 60–75, fructu et nuce majore.

strong lens, not at all tomentose, the fascicled hairs without glandular bases, the surface lepidote with many pale glands, rarely completely free of hairs; upper surface of mature leaflets glabrous or with scattered minute appressed fascicles of hairs along the veins; sepals of staminate flowers, in addition to bract and two bracteoles, commonly 6–8, or even 14; young pistillate flowers whitish-tomentose; immature fruit pyriform, densely to lightly fascicled hairy, the hairs minute, evanescent, to rather glabrate, about 2 flowers on each peduncle, the peduncle proper 2 cm. long, peduncle and rachis together 2.5–3 cm. long; mature fruit about 3.6 cm. in diameter, 4 cm. long, with thin husk, wrinkled when dry, very inconspicuously verrucose, subglobose to broadly ovate, with some scattered glandular pubescence; nut dark brown, subglobose to ovate, 3–3.4 cm. in diameter, 3–4 cm. long, with broad, flat-topped to rounded fairly high to shallow broken ridges, the general appearance essentially strongly longitudinally striate; secondary partition rather high, the primary wall lacunae absent.

VERNACULAR NAMES: *nogal*; *nogal de Uriqui* (Jalisco, fide Martinez).

DURANGO: San Ramon (80 mi. w. of Tepehuanes, nw. Durango), *Palmer 104* im. fr. (GH, K, NY, US). — Sianori, alt. 800 m., *Ortega 5350* stam. (K, MEX, US). JALISCO: Guadalajara, *Rose & Hough 4805* im. fr. (US). MICHOACAN: Coalcomán, Sierra Naranjillo, alt. 1350 m., *Hinton 13759* stam. (GH, US). MEXICO: Naranjo, district Temascaltepec, *Hinton 3807* stam., pist. (K, NY, ST, US). — Luvianos, district Temascaltepec, *Hinton 3973* im. fr. (TYPE-AA, K, US). GUERRERO: Acamixtla, n. of Taxco, *Martinez* in 1942 fr. (WEM). — 7 mi. ne. of Taxco, ravine by stream, alt. 6000 ft., *W. E. & M. S. Manning 531005* fr., *531020*, *531021*, *531023* fr. (WEM). — Chilapa, *Hernandez X. X3167* fr. only (WEM).

This variety may, upon further study, prove to be a distinct species. The writer was unable to locate trees of this taxon in the Guadalajara region. Nuts from the original collection at Guadalajara were planted in California, and fruiting trees are now found at Davis and Riverside. These trees are used as the source of understock for buddings of *J. regia*; they are reported to be subevergreen there, being without leaves for less than a month. In Taxco, wood presumably of this taxon is used locally to make fine furniture.

This taxon is similar to *J. mollis* in having 11–15 leaflets and rather large fruits. The bases of the leaflets are typically tapering in *J. major* var. *glabrata*, and rounded or truncate in *J. mollis*, but as the leaflets are commonly oblique in most species this distinction is not always evident. The lower surface of the leaflets is glabrate or with a few appressed fascicled hairs in *J. major* var. *glabrata* and tomentose in *J. mollis*. The rachis of *J. mollis* is much hairier, with either fascicled hairs or brown, glandular ones. The nuts of *J. major* var. *glabrata* are typically more deeply grooved than in *J. mollis*. As mentioned under *J. mollis*, *Muller 1156* from Nuevo León may be *J. major* var. *glabrata*; this would represent a tremendous extension of range.

The differences between *J. major* forma *stellata* and the members of the northern race of *J. major* closest to *J. mollis*, are given under the description of that form.

The true distinctions between *J. major* and *J. microcarpa* have always been problematic and many authors consider *J. major* a variety of *J. microcarpa* (or of *J. rupestris*) since they seem to intergrade in their features. One reason for this in the United States may be that *J. microcarpa* and *J. nigra* may hybridize in certain regions, such as Oklahoma, and the resulting hybrids appear to be *J. major*.

Sudworth (1934) gave in his key (prepared by W. A. Dayton) the main distinctions separating *J. rupestris* and var. *major*. In addition, Johnston (1944, p. 437) states that the leaflets of *J. major* are evidently short-petiolulate, with the bases of the leaflets strongly oblique, with one side of the blade decurrent on the petiolule for at least a millimeter, while the curved, more elongate leaflets of *J. microcarpa* are subsessile with the blade decurrent only very obscurely, if at all. The writer agrees with Johnston, in general, but believes there is some deviation in both species. Scott (1954, Plate 15, figs. 17, 18, 20, 21) illustrates the seeds of *J. major* and *J. microcarpa* as quite different and he believes that these features will always separate the two species. Preliminary observations by the writer, however, indicate that the embryo of *J. major* as figured by Scott is not typical of the species and that most of the seeds are closer to the illustration of *J. microcarpa*. Consequently, Scott's distinction does not hold. This feature, however, is worth further study. Scott made his study by filling the seed-cavities of the nut with soft metal, after which he removed the woody pericarp with strong sulphuric acid, leaving a metallic cast of the seed. The writer has cut nuts in half, then painted the seed cavity with latex, and finally removed the mold of the upper half of the seed.

Since the writer's key to the species brings out only one or two distinctions between *J. microcarpa* and *J. major*, species which grow not far from each other and which are often confused, Sudworth's key is repeated here with some changes and additions. This key applies primarily to the northern race of *J. major*, as this taxon is closer to *J. microcarpa* than the southern race.

1. Leaflets 17–23, rarely to 31, lanceolate, mostly narrowly so, about 1–1.5 cm. broad, usually falcate, finely serrate or nearly entire, subsessile, mostly rounded at the base, long tapering at the apex; fruit 12–20 mm. in diameter; nut 10–17 mm. in diameter, the lacunae of the wall much reduced; stamens about 20–30; much-branched, round-headed shrub or small tree, ranging from Texas to western Oklahoma and southeastern New Mexico into nw. Nuevo León, Coahuila, and ne. Chihuahua. *J. microcarpa*.
1. Leaflets 9–15, rarely 17, oblong-lanceolate to ovate, 1.7–3.4 cm. broad, acuminate, usually coarsely serrate but sometimes finely serrate, usually short-stalked, strongly oblique, with one side of the blade decurrent on the stalk for at least a millimeter; fruit mostly 23–35 mm. thick; nut 18–30 mm. in diameter, the lacunae of the wall prominent; stamens about 30–50;

medium-sized tree, occasionally 50–60 feet high, with well-defined trunk and narrow crown, ranging from central and southern New Mexico and Arizona to Chihuahua, Sonora, Sinaloa, and Durango. *J. major*.

The range of typical *J. major* is shown in the key above. Details of the range in the United States will be found in Sargent (1933), Sudworth (1934), and Benson (1944). The distribution as shown on the map in Sudworth is not accurate for Mexico. The distributions in Mexico of *J. major*, its one variety and one form is shown on Map 1 of this paper.

5. *Juglans microcarpa* Berlandier in Berl. & Choval, Diario Viage Comision de Limites baja Mier y Teran 276. 1850; Johnston, Jour. Arnold Arb. 25: 436. 1944.

Juglans nana Engelm. Proc. Amer. Assoc. Adv. Sci. 5: 226. 1851.

Juglans rupestris Engelm. ex Torr. in Sitgreaves, Rep. Exped. Zuni & Colorado Rivers 171, t. 15. 1853; Dode, Bull. Soc. Dendrol. France 1909: 189. 1909; Standley, Contrib. U. S. Nat. Herb. 23: 165. 1920; Sudworth, Poplars, Principal Tree Willows and Walnuts of the Rocky Mountain Region, U.S.D.A. Tech. Bull. 420: 98. 1934.

Juglans subrupestris Dode, Bull. Soc. Dendrol. France 1909: 191. 1909.

Much-branched, round-headed shrub or small tree; young twigs slender, orange-red and strongly lenticellate, finely whitish glandular-pubescent or -puberulent during their first winter, the second year slender, ashy gray, often puberulent; terminal bud slender; leaves moderate or small, usually unequally pinnately compound; rachis usually finely whitish-puberulent; leaflets usually 19–23, rarely 17 or more, opposite or alternate, subsessile, lanceolate or narrowly lanceolate, usually 1–1.5 cm. wide (or to 1.9 cm. in var. *stewartii*), and 5–8 (–11?) cm. long, typically rounded at the base, but occasionally oblique, acuminate and long-tapering at the apex, usually falcate, finely serrate or frequently revolute and almost entire, finely pubescent beneath or rarely glabrate; staminate catkins 7–11 cm. long, very slender, the individual floral bracts small, whitish-tomentose, on the backs of the flowers; stamens 20–30; pistillate flowers solitary or few, whitish- or reddish-puberulent; fruit globose or subglobose, pubescent or puberulent, 1.2–2.1 cm. in diameter; nut 1–1.7 cm. in diameter, subglobose, longitudinally ridged or striate, sometimes with definite dorsal lips; dorsal partition rather low, lacunae typically reduced to canals or almost points.

VERNACULAR NAMES: *nogal*; *nogalillo*.

NUEVO LEON: Lampazos, Rancho Resendez, Mary T. Edwards 420 fr. (CAL, MEX). COAHUILA: Cañon de San Enrique, east side of Sierra de la Encantado, nw. Coahuila, Stewart 1390. — Cañon del Indio Felipe, Sierra Hechiceros, close to Chihuahuan border, lat. 28° 33', Stewart 134A (GH). — 6 mi. e. of El Tule, 24 km. n. of Castillon, and close to Chihuahuan border, southern foothills of igneous Sierra Hechiceros, Stewart 482 fr. (GH). — Sabinas, Nelson 6787 (or 6187?) fr. (COP, ST, US). — Musquiz, Hacienda Mariposa, near Puerto Santa Ana, Wynd & Muller 283 (GH, ILL, K, MEX, US). — Musquiz, Flores Pasture, Hac. Mariposa, Marsh 313 fr. (GH). — Vicinity of La Noria, Sierra del Pino, Johnston & Muller 509 fr. (GH). — Municipio de Castanos,

cañon Bocatoche, *Muller* 3120 fr. (CAL, GH, USDA, WEM). — 9 mi n. of Hipolito, *Johnston* 7229 fr. (GH). — Guadeloupe, *Aguirre* in 1942, pist. (NY, WEM).

This species is the smallest in stature and has the smallest fruit of any known walnut. It is easily distinguished from all other species of *Juglans* of Mexico, with the possible exception of *J. major*, by the narrow leaflets and small fruit. The differences between *J. microcarpa* and *J. major* are discussed above under the latter species and in the key given there is the range of the species in Mexico and the United States. The distribution in Mexico as shown on the map in Sudworth (1934) is not accurate.

In northwestern Coahuila and northeastern Chihuahua there are shrubs or trees intermediate in certain respects between *J. microcarpa* and *J. major*. This taxon, possibly a hybrid race, has been called *J. major* var. *stewartii* by Johnston, but because the number of leaflets is within the range of *J. microcarpa*, this variety is here transferred to that species:

5a. *Juglans microcarpa* Berlandier var. *stewartii* (Johnston) Manning, comb. nov.

Juglans major (Torr.) Heller var. *stewartii* Johnston, Jour. Arnold Arb. 25: 437. 1944.

COAHUILA: Sierra Hechiceros, Cañon del Indio Felipe, nw. Coahuila, *Johnston & Muller* 1358 fr. (TYPE-GH); *Stewart* 134 fr. (GH). — CHIHUAHUA: Cañon de la Madera, southeastern flank of Sierra Rica, north of Rancho de la Madera, oak pinon belt, (west of Manuel Benavides or San Carlos), tree or shrub, *Stewart* 2557 (GH).

This variety has the number of leaflets 17–21 (or to 32 in *Stewart* 2557), these with long drawn out tips, as in *J. microcarpa*, but the leaflets are frequently broader (1.1–1.9 cm. wide), usually with an oblique base; the fruits average larger (1.8–2.5 cm. in diameter). In the single, probably atypical specimen of *Stewart* 134 there are only 17 leaflets, but the other collections given above have higher numbers. The writer believes that *Muller* 7968, from Chisos Mts., Brewster Co., Big Bend National Park, Texas belongs to this variety; in the nuts of this specimen the lacunae are rather large.

Johnston (1944), in discussing the variety, states "A plant agreeing with the western *J. major* in its arborescent habit, large fruits, and oblique leaflet-bases, and resembling *J. microcarpa* in its numerous elongate leaflets."

6. *Juglans olanchana* Standley & Williams, Ceiba 1: 76. 1950.

Juglans guatemalensis Manning, Amer. Jour. Bot. 35: 616. 1948, nomen subnudum; in Standley & Steyermark, Flora of Guatemala, Fieldiana: Botany 24(3): 356. 1952.

Medium-sized or large tree. the bark dark and deeply furrowed; twigs dark brown, appearing glabrate, but minutely glandular-puberulent, the lenticels prominent; leaves large, mostly 45–65 cm. long and 30–35 cm.

wide, the terminal leaflet usually present; leaflets large, distant, chiefly 17–21, each 14–17 cm. long and 5–6 cm. wide, decidedly stalked, the stalk 2–4 mm. long; leaflets finely to strongly serrate, oblong-elliptic to ovate, obliquely truncate or rounded at the base above the stalk, commonly cuneate on the lower side, long-acuminate at apex, the lowest leaflets frequently small; lower surfaces of leaflets glabrate, with only a few stalked glands and a few minute fascicled hairs on midrib and a few on larger lateral nerves, inconspicuously lepidote, young leaflets with whitish pointed hairs on the smallest veins; very young leaflets drying green, with almost no fascicled hairs beneath; upper surface of leaflets glabrate; rachis glabrous or glabrate, but under a strong lens appearing densely puberulent with minute stalked glands; staminate catkins (15–)22–30 cm. long, the bracts, small, 1 mm. long, obtuse, short-hairy, essentially on the catkin-rachis at the base of the flower-stalk throughout the catkin; flower-stalk well developed, 4–5 mm. long; the bracteole-sepal ring frequently with 8 organs; stamens 61–102; pistillate flowers and immature fruits unknown; peduncle and rachis of fruiting spike together 8 cm. long; mature fruit large, subglobose-pyriform, 4.3–4.5 (–5.5) cm. thick and 4.7–4.8 (–5.8) cm. long, to essentially glabrous, shining greenish brown, strongly and conspicuously white punctate-verrucose (warty), with the punctations open and lenticel-like, not wrinkled in drying, the husk thick; nut reddish brown, subglobose, slightly flattened, 3.4–4.5 cm. thick and 3.2–4.2 cm. long, strongly ridged, the ridges broad, flat-topped, interrupted, rather rounded in cross-section, the furrows comparatively shallow except at the depressed base of the nut, where the ridges are sharp and the furrows deep; primary wall cavities usually well developed at all levels, frequently united with tertiary wall cavities, and at the very base of the nut uniting also with secondary wall cavities; secondary wall-cavity ridges strongly projecting into the loculus at the one-celled level and at least in one collection at the 2-celled level; secondary septa rather low.

VERNACULAR NAMES: *nogal*; *nuez*.

GUATEMALA: Alta Verapaz: Tucuru, *Popenoe 265a* nuts only (AA, BPI). Baja Verapaz: Finca Chejel, *Popenoe 180a* nuts only (AA, BPI). Quiche: Finca San Francisco, Cotzal, alt. 3800 ft., *Skutch 1866* fr. (AA: TYPE of *J. guatemalensis*; CM, NY). Huehuetenango: 5 mi. se. of Barillas, Sierra de los Cuchumatane, cafetal of Finca Soledad, alt. 1150 m., *Steyermark 49544* fr. (CM, WEM). — Above Democracia on trail towards Jutal, alt. 1000 m., *Steyermark 51072* (CM). Guatemala: Antigua, cultivated in finca, Standley, in 1939, nuts only (CM). — Guatemala, cultivated, *Lewis 1125* stam. (CM); *Morales 624* stam. (US).

HONDURAS: Olancho: Catacamas, common in moist forest along rio de Catacamas, alt. 450 m., *Standley 18159* fr. (TYPE-CM, HON). — *Standley 18149* stam. (CM, HON). Morazan: Mont. de la Flor., Rio Guarabuqui, *Molina A-3009* fr. (CM). — Along river, alt. 2600 ft., *C. & W. Von Hagen 1271* (CM, NY).

SALVADOR: cultivated: San Salvador, *Standley 22637* (GH, NY, US). — *Calderon 1528* stam. (GH, US). — Finca San Nicolas, *Calderon 1570* im. fr. (US). — Playa Santiago de Maria, Dept. Usulután, alt. 150 m., *Carlson 656* (CM). —

Dept. Sonsonate, brush slope south of headquarters of Hacienda Las Tablas, near Rio Acachapa, Balsam Range, alt. 660 m., *Tucker 1364* fr. (CAL, GEN, NY).

NICARAGUA: cultivated: Dept. Managua, vicinity of Casa Colorado near El Crucero & summit of Sierra de Managua, planted in hedge of finca, *Standley 8209* (CM).

The description above seems to differ radically from the original description by Standley & Williams of *J. olanchana*. Their description reads, in part: "folia magna, 10–12-foliolata, petiolata, rhachi dense puberula; — amenta mascula — 13–17 cm. longa." The writer has studied the two sheets cited by these authors, and believes that the leaflets, some of which have fallen off, are more numerous than stated in the description; the difference in the description of the pubescence is merely a matter of interpretation.

As stated in the Flora of Guatemala, "The collections of Popenoe and of Standley (in Guatemala) are represented only by nuts, and there is some uncertainty about the identification; the collection of Steyermark has the internal cavities absent at the end of the primary partition in the nut. This may be the species reported by Rene Guerin (as *nogal*, *Juglans nigra*), in Catalogue des produits presentes par la Republique de Guatemala a l'exposition universelle de Paris, 1900, from Coban, Alta Verapaz; Cuilapa, Santa Rosa; Chimaltenango, Zacapa, and Chiquimula."

This native walnut (*J. olanchana*) of Guatemala and Honduras has been called for many years *Juglans pyriiformis* and is undoubtedly closely related to it. The fruit of *J. olanchana* is quite similar to the fruit of *J. pyriiformis*, but the leaves are entirely different, with the leaflets mostly 17–21, strongly stalked, frequently cuneate at least on the lower side at the base, as opposed to leaflets 19–31, sessile, truncate. The cross section of the nut of *J. olanchana* resembles that illustrated by Dode (1909) for *J. peruviana* (*J. boliviana*, according to the writer).

The identification of *Steyermark 51072* is uncertain, as the young leaves have 17–25 leaflets, which are slightly more hairy than in typical *J. olanchana* with colorless pointed hairs beneath.

Certain specimens cultivated in Salvador (i.e. *Calderon 1570*) are quite different from what the writer considers typical *J. olanchana* and closely resemble *J. major* var. *glabrata* in having smaller leaves, fewer (13–15), narrower (2.5–3.5 cm. wide by 8–11.5 cm. long) leaflets whose bases are strongly cuneate on both sides. In *Calderon 1528*, which has about 19 leaflets but small and narrow as in *Calderon 1570*, the staminate catkin is only 9 cm. long. C. & W. Von Hagen 1271, from Honduras, is similar to these specimens, although it should be noted that *Molina A3009*, from the same general region, has leaves characteristic of *J. olanchana*. Mature fruits are lacking on these specimens. Whether these atypical specimens are variants of *J. olanchana*, poorly collected specimens of *J. olanchana* (such as young shoots), true *J. major* var. *glabrata*, or a different species is uncertain. These plants need further study. It should be pointed out that Standley & Calderon, in *Lista Preliminar de las Plantas de El Salva-*

dor, in 1935, stated that *Juglans pyriiformis* Liebm., *nogal*, planted in many places in Salvador, was introduced from Mexico. The writer believes that all walnuts in Salvador and Nicaragua have been planted, and most specimens from these countries are so marked; no statement, however, is made on the labels of *Carlson 656* and *Tucker 1364*.

Skutch states, in a note concerning his specimen, that near Cotzal "there were a number of huge trees standing in the cleared lands near the river, 175 feet high. From the size and appearance of the trees, coupled with what I heard of the relatively recent date of the clearing, I had no doubt that they were relics of what must have been an extraordinarily magnificent forest. They were associated with a sycamore which here also seemed to be near the southern limit of its range." Popenoe, concerning his No. 180a states that "the tree, seen occasionally on mountain sides and along water courses, at elevations of 1500–4500 ft. . . . is only moderately large, rarely reaching a greater height than 40–45 feet."

Record & Hess (1943) state that a wood, *Yale 300*, probably a walnut, called "Cedro Nogal" has been obtained in Copare, Honduras. In a recent letter William L. Stern, of the Yale School of Forestry, has informed the writer that *Yale 300* is called "Cedro Negro" and came from the Comya district, Dept. of Copan, Honduras. This wood was exhibited at the 1904 St. Louis Exposition.

Two collections from western Mexico are similar to *J. olanchana* in having large leaves with 17–20 large, lanceolate to oblong-lanceolate leaflets, staminate catkins 23–29 cm. long, the bracts of the large flowers short, located on the rachis or the very base of the pedicel, large light brown nuts strongly longitudinally furrowed with broad flat ridges. These are here described as a new variety:

6a. *Juglans olanchana* Williams & Standley var. *standleyi* Manning, var. nov.*

This differs from typical *J. olanchana* in having the twigs, rachis, and leaflets conspicuously hairy, and the leaflets essentially sessile or with a short broad stalk, tapering somewhat on both sides at the base but especially on the lower side.

Twigs densely glandular-villous with whitish hairs, gummy (fide Ynes Mexia); rachis stout, densely and strongly pale-brown glandular-villous; leaflets 12 cm. long and 4–4.5 cm. wide, conspicuously and densely finely whitish tomentose with fascicles of long hairs beneath, each fascicle lacking a bulbous base, with strong tufts of hairs at bases of side veins, very finely and remotely serrate, appearing nearly entire, possibly because of the subrevolute margin, lepidote under the hairs with golden glands, the midrib with glandular hairs; upper surface of leaflets with most of strong veins glandular-pubescent, some fascicled hairs being present toward base of midrib; pistillate flowers unknown; husk of fruit unknown; nuts subglobose, 3.2–3.5 cm. in diameter, 3.2 cm. long, somewhat compressed.

* A *J. olanchana* differt ramulis, rhachibus et foliolis conspicue pilosis, foliolis subsessilibus, basi angustatis.

COLIMA: San Antonio, *Reiche*, in 1913, *stam.* (MEX). JALISCO: San Sebastian, Sierra Madre Occidental (Sierra Madre del Sur?), *Ynes Mexia* 1438 fr. (TYPE-NY; ISOTYPES-AA, CAL, CM, GH, GEN, MICH, MO, US, BPI).

Husks which might correlate this variety more fully with *J. olanchana* have not been collected. This taxon may prove, upon further study, to be a distinct species.

The hairs are somewhat similar to those of *J. mollis* or *J. hirsuta*, but are extraordinarily developed; the leaflet base, the length of the staminate catkin, the position of the staminate bract, and the nuts are quite different.

7. *Juglans steyermarkii* Manning in Standley & Steyermark, *Flora of Guatemala*, *Fieldiana: Botany* 24(3): 358. 1952; in *Amer. Jour. Bot.* 35: 616. 1948, *nom. subnud.*

Tree about 50 feet tall, the bark gray and furrowed; twigs densely glandular pubescent; terminal bud elongate, densely grayish tomentose; leaf-scar only slightly notched; leaves large, up to 60 cm. long and 30 cm. wide, the terminal leaflet usually absent; rachis conspicuously pubescent with reddish glandular hairs; leaflets large, distant, mostly 16–18, each 14–17 cm. long and 5–8 cm. wide, essentially sessile or very short-stalked, ovate or ovate-lanceolate, typically finely but rather remotely serrate with the serrations shallow and turned outward, and with most of the small veins terminating in the teeth rather than the sinus; upper surface of leaflets pubescent with minute glandular hairs, the lower surface pubescent with reddish glandular hairs on larger and smaller veins and especially on the midrib and with solitary or paired whitish pointed hairs on the surface and smaller veins; base of leaflet usually truncate to broadly rounded, the apex acute or abruptly acuminate, the lowest leaflet somewhat reduced; flowers unknown; nearly mature fruit wrinkled, subglobose-pyriform, truncate at the base, 4 cm. in diameter and 4.5 cm. high, strongly pubescent with reddish glandular hairs; punctations numerous, drying brown, very inconspicuous; husk not very thick; nut apparently deeply grooved, with rounded ridges, but nut immature; cavities present in the wall at each end of the primary partition.

VERNACULAR NAME: *nogal*.

GUATEMALA: Huehuetenango: Paso del Boqueron, along Rio Trapichillo, below La Libertad (west of Jacaltenango, almost on Mexican border), alt. 1200–1300 m., *Steyermark* 51140 fr. (CM, WEM).

This species is completely different vegetatively from *J. olanchana*; the husk is different, also. Unfortunately the nut is immature, so that it is impossible to compare the nuts of the two Central American species.

Although *J. olanchana* has a fruit similar to that of *J. pyriformis* of eastern Mexico, it is similar to the species of western Mexico in its narrow leaflet bases and type of hairiness. *Juglans steyermarkii*, on the other hand, is similar vegetatively to the eastern Mexican species with truncate leaflet bases and brownish pubescent rachises. The differences

between *J. steyermarkii* and the eastern Mexican species are given in the main key to species.

Both *J. olanchana* and *J. steyermarkii* occur within a few miles of the border of Chiapas, Mexico, and it is very probable that one or both species may occur in that state of Mexico.

INTERRELATIONSHIPS OF SPECIES OF THE NEW WORLD

With the exception of *Juglans cinerea*, all species of the New World are closely related and have probably evolved from one or two common ancestors.

Juglans boliviana (C. DC.) Dode and *J. columbiensis* Dode, of South America, are similar in vegetative features to *J. olanchana* and *J. major* var. *glabrata*. *Juglans neotropica* Diels, of northern South America, has truncate leaflet-bases as in *J. mollis*. *Juglans australis* Griseb. of Argentina and Brazil is similar to *J. major*.

The one (two?) species of *Juglans* of the West Indies is similar vegetatively to *J. olanchana* and *J. pyriformis* but is also similar to *J. columbiensis* Dode of Venezuela.

The nuts of all species of Latin America are very similar, most of them having rather flat-topped ridges. It is almost impossible to identify positively any nut of this area by itself. Dode (1909) has natural-size drawings of the nuts of many species, showing for each nut the external appearance, a cross-section at the middle, and a longitudinal section along the dorsal partition. These illustrations include not only the Mexican species but also the species from South America and the West Indies. The Mexican species illustrated are *J. pyriformis* Liebm., *J. mollis* Engelm. (represented by Pringle 3322 which is unusual in having dorsal lips), *J. major* (Torr.) Heller (as *J. arizonica* Dode, *J. neomexicana* Dode, *J. torreyi* Dode, *J. elaeopyren* Dode) and *J. microcarpa* Berlandier (as *J. rupestris* Engelm. and *J. subrupestris* Dode). The nuts of some species not illustrated by Dode, such as *J. hirsuta* Manning and an unnamed species of South America, with sharply ridged nuts, as in *J. nigra* L., are different.

The species of *Juglans* of South America and the West Indies will be treated by the writer in a later paper.

The species of *Juglans* of Central America probably gave rise to those of Mexico and the United States. There seem to have been three principal lines of evolution, an eastern, a western, and a central branching one. In the east *J. pyriformis* has arisen from *J. olanchana*, though the leaflet-bases are similar to those of *J. steyermarkii*. *Juglans olanchana* is represented in extreme western Mexico by its variety *standleyi*. In central Mexico *J. major* var. *glabrata* is similar in many ways to *J. olanchana* and has, in turn, evolved into the more eastern *J. mollis* and into the more western *J. major*, *J. microcarpa*, and *J. californica*. *Juglans mollis* has the truncate leaflet bases of *J. steyermarkii* and *J. pyriformis* and there may have been some cross breeding; *J. mollis* and *J. major* have fewer leaflets than typical *J. olanchana*. *Juglans hirsuta* seems to be a combination

of *J. mollis* and *J. pyriformis*, though it might have evolved directly from *J. pyriformis*; *J. hirsuta* has in turn evolved into *J. nigra*.

McVaugh (1952) on page 332 (Map 10) shows the locations of many areas in northern Mexico and western United States where *Juglans* is found; he considers *Juglans* in that area to be one species, *J. microcarpa* Berl.

The map in this paper shows the localities where the seven species, three varieties and one form of *Juglans* treated in this paper have been collected. The legend on the map is self-explanatory.

A study of future collections may affect the concepts of taxa in this paper.

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VEGETATION ON BAUXITIC SOILS IN JAMAICA, II

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THE FIRST PART OF THIS PAPER (Jour. Arnold Arb. 38: 1-41, 1957) described the vegetation of Jamaica in areas of commercial accumulations of bauxite ores and considered the relationship of this vegetation to the aluminum ions in the soils. Also considered were the effects of the mining operations on the vegetation as well as the terrain. The surveys of the vegetation made by the authors on lands to be mined and on lands adjacent to the mined-out areas where seed trees could contribute to the revegetation of abandoned mine pits were described. Certain pits from which the available bauxitic ore has been removed were designated as control pits to observe the invasion, succession and competition of natural reseeding. Other mined-out pits have been resurfaced or recontoured and planted to pasture grasses, stands of forest trees, or agricultural crops of vegetables and fruits. We have commented on the success of these rehabilitation attempts to the present.

Throughout their study of the vegetation on bauxite soils in Jamaica both authors have searched for undisturbed areas of vegetation in which could be found indications of a selection through survival of plants tolerant to or requiring aluminum ions for their persistence. Such plants they felt might be considered as indicators of aluminum concentrations and therefore of further aid in both an interpretation of vegetation types in other parts of Jamaica as well as being a valuable aid in the search for additional aluminum deposits. They have indicated that in neither the parish of St. Ann near the operations of the Reynolds Jamaica Mines nor in the parish of St. Elizabeth near the mining operations of Kaiser Bauxite Company could they find undisturbed areas of forest, shrub or herbaceous vegetation. All have shown the effects of man's long occupancy of the respective areas through gardening, pasturage or forest utilization. Mining operations are to the present being conducted on lands with a long history of agricultural usage. Further development in the parishes of Trelawny and Portland should reveal less disturbed vegetation associated with bauxite.

The following tabulation is a summary of our findings to date. Listed are the species which we have found by a careful study of the existing vegetation in the two principal areas of commercial bauxite mining in Jamaica. Species are listed according to the genera and families of their relationship and, for the sake of convenience, are alphabetical. The ferns and allied non-flowering plants have been grouped together. The monocotyledons are listed before the dicotyledons. Species lists are presented for the area of Reynolds Jamaica Mines operations in the parish of St. Ann and for the area of mining operations of the Kaiser Bauxite Company in the parish of St. Elizabeth. We have tabulated the species as they occurred in three arbitrary divisions for each area. Representatives of

both the Reynolds Jamaica Mines and the Kaiser Bauxite Company were willing to indicate for us those areas which were to be mined immediately or in the near future. Our prime efforts were to obtain records, supported in most cases by herbarium vouchers, of the vegetative components on lands to be mined. Such areas comprised bauxite deposits at least five feet deep. They varied in surface area from two to nearly sixty acres. Many of these areas have since been mined out and of these some have been replanted. The species listed under the heading "To be Mined" were collected in such areas. Photographs document the original vegetation and subsequent stages of rehabilitation. Other areas too small or too shallow for commercial mining operations may have comparable concentrations of aluminum ions in the bauxitic soils. These were examined by us, but failed to yield any species not listed in the tabulation under "To be Mined."

Adjacent to, or intermingled with the bauxite ore bodies were limestone outcrops in the mining areas in both St. Ann and St. Elizabeth. The limit of bauxite soils in many cases was defined by the outcrop of limestone rock. Such areas of limestone rock will not be altered by mining operations. The vegetation on these outcrops has been studied and reported in the first part of this paper. One undisturbed, or at most slightly disturbed, unit of forest vegetation was found on such an outcrop in St. Elizabeth. In St. Ann every forest unit studied appears to have been cut selectively some time in the past. Nevertheless, one source of natural seeding in the mined-out pits will be from mature trees or shrubs located in the vegetation currently found on the limestone outcrops. The species we have collected in such areas are listed under the heading "Adjacent" for both St. Ann and St. Elizabeth. The vegetation of the limestone outcrops is perhaps the most typical expression of the native vegetation of each area. The differences between the native vegetation of the drier area in St. Elizabeth parish and that of the more moist area in St. Ann can be seen in these tabulations which are more complete than the quadrat and transect studies of PART I. We have listed the epiphytes and parasites for a complete record, even though the distribution of these cannot be attributed to the occurrence of bauxite soil.

A third tabulation under the heading of "Invaders" lists those species which have been observed in the control pits where only natural seeding and invasion has occurred as well as mined-out and rehabilitated pits where some species have been planted and others have appeared spontaneously. It is to be expected that this category will show additions as time goes by and some deletions as early invaders succumb to competition. All listings are based on field observations between December 1953 and September 1956. Specimens validating the species listed are filed in the herbarium of the Institute of Jamaica in Kingston, Jamaica, B.W.I., and in the Harvard University Herbarium in Cambridge, Massachusetts.

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
FERNS & FERN ALLIES						
<i>Adiantum fragile</i>			X			
<i>Adiantum latifolium</i>		X				
<i>Adiantum pulverulentum</i>		X				
<i>Adiantum tenerum</i>		X				
<i>Aneimia adiantifolia</i>		X				
<i>Asplenium auritum</i>		X				
<i>Asplenium dentatum</i>		X				
<i>Asplenium jamaicense</i>		X				
<i>Cheilanthes microphylla</i>		X			X	
<i>Ctenitis effusa</i>		X				
<i>Dennstaedtia cicutaria</i>			X			
<i>Lomariopsis underwoodii</i>		X				
<i>Lycopodium linifolium</i>		X				
<i>Maxonia apiifolia</i>		X				
<i>Nephrolepis biserrata</i>	X	X				
<i>Nephrolepis exaltata</i>	X	X		X		
<i>Ophioglossum palmatum</i>		X				
<i>Paltonium lanceolatum</i>		X				
<i>Pityrogramma calomelanos</i>		X				
<i>Polypodium angustifolium</i>		X				
<i>Polypodium astrolepis</i>		X				
<i>Polypodium aureum</i>		X				
<i>Polypodium crassifolium</i>		X				
<i>Polypodium heterophyllum</i>		X				
<i>Polypodium lycopodioides</i>		X				
<i>Polypodium pectinatum</i>		X				
<i>Polypodium phyllitidis</i>		X			X	
<i>Polypodium phyllitidis</i> <i>f. latum</i>		X				
<i>Polypodium piloselloides</i>		X				
<i>Polypodium plumula</i>		X			X	
<i>Polypodium polypodioides</i>		X			X	
<i>Polystichum christinae</i>		X				
<i>Polystichum echinatum</i>		X	X			
<i>Psilotum nudum</i>		X				
<i>Pteridium caudatum</i>		X	X			
<i>Pteris grandifolia</i>	X	X				
<i>Pteris longifolia</i>	X	X	X			
<i>Tectaria apiifolia</i>		X				
<i>Tectaria heracleifolia</i>		X				
<i>Thelypteris asterothrix</i>		X				
<i>Thelypteris guadalupensis</i>		X				
<i>Thelypteris normalis</i>		X				
<i>Thelypteris oligophylla</i>		X				
<i>Thelypteris reptans</i>		X				
<i>Thelypteris serra</i>		X				
<i>Thelypteris serrulata</i>		X				

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
<i>Thelypteris tetragona</i>		X	X			
<i>Vittaria lineata</i>		X				
MONOCOTYLEDONEAE						
Amaryllidaceae						
<i>Agave sisalana</i>					X	
<i>Hypoxis decumbens</i>			X			
Araceae						
<i>Anthurium grandifolium</i>		X				
<i>Anthurium scandens</i>		X				
<i>Colocasia esculenta</i>						P*
<i>Philodendron lacerum</i>	X		X		X	
<i>Syngonium auritum</i>					X	
Bromeliaceae						
<i>Aechmea paniculigera</i>		X				
<i>Catopsis berteroniana</i>		X				
<i>Catopsis nutans</i>		X				
<i>Guzmania lingulata</i>		X				
<i>Guzmania monostachya</i>		X				
<i>Hohenbergia polycephala</i>		X				
<i>Hohenbergia spinulosa</i>					X	
<i>Tillandsia balbisiana</i>		X			X	
<i>Tillandsia compressa</i>		X				
<i>Tillandsia festucoides</i>		X				
<i>Tillandsia flexuosa</i>					X	
<i>Tillandsia recurvata</i>		X			X	
<i>Tillandsia schiedeana</i>					X	
<i>Tillandsia tenuifolia</i>		X			X	
<i>Tillandsia usenoides</i>					X	
<i>Tillandsia utriculata</i>					X	
<i>Tillandsia valenzuelana</i>		X				
Commelinaceae						
<i>Campelia zanonina</i>		X				
<i>Commelina elegans</i>			X	X		
<i>Tradescantia multiflora</i>		X				
Cyperaceae						
<i>Cyperus filiformis</i>				X		
<i>Cyperus ligularis</i>		X				
<i>Dichromena ciliata</i>	X		X			
<i>Fimbristylis annua</i>			X			
<i>Rhynchospora pusilla</i>		X	X			
<i>Scleria lithosperma</i>		X			X	X
<i>Scleria pterota</i>			X			

* Species deliberately planted for cultivation are indicated with a "P". Cultigens occurring spontaneously as invaders are recorded with an "X".

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
Dioscoreaceae						
<i>Dioscorea alata</i>		X				
<i>Dioscorea polygonoides</i>		X				
Gramineae						
<i>Andropogon glomeratus</i>	X		X	X		
<i>Andropogon virginicus</i>				X		
<i>Antheophora hermaphrodita</i>						X
<i>Axonopus compressus</i>			X	X		
<i>Bambusa vulgaris</i>	X					
<i>Cenchrus brownii</i>			X			
<i>Cenchrus echinatus</i>				X		X
<i>Cenchrus gracillimus</i>				X		
<i>Chloris petraea</i>				X		X
<i>Chloris radiata</i>			X			
<i>Digitaria decumbens</i> (Pangola Grass)	P					
<i>Digitaria sanguinalis</i>			X	X		X
<i>Eleusine indica</i>	X		X	X		X
<i>Eragrostis ciliaris</i>				X		
<i>Ichnanthus pallens</i>		X	X			
<i>Lasiacis divaricata</i>		X			X	
<i>Lasiacis sloanei</i>					X	
<i>Lasiacis sorghoidea</i>					X	
<i>Leptochloa domingensis</i>				X		
<i>Melinis minutiflora</i> (Wynne Grass)			P			P
<i>Panicum adspersum</i>				X		
<i>Panicum maximum</i> (Guinea Grass)			P			P
<i>Panicum purpurascens</i> (Para Grass)			P			P
<i>Paspalum blodgettii</i>	X		X			
<i>Paspalum caespitosum</i>				X	X	
<i>Paspalum conjugatum</i>	X		X			
<i>Paspalum fimbriatum</i>			X	X		X
<i>Paspalum notatum</i>	X		X	X		
<i>Paspalum paniculatum</i>	X	X				
<i>Paspalum propinquum</i>			X	X		
<i>Pennisetum purpureum</i>			X	X		
<i>Pharus glaber</i>					X	
<i>Setaria geniculata</i>	X		X	X		X
<i>Sorghum bicolor</i>			X			
<i>Sporobolus indicus</i>				X		X
<i>Stenotaphrum secundatum</i>	X	X	X	X		
<i>Trichachne insularis</i>		X	X	X		X
<i>Zea mays</i>			X			

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
Iridaceae						
<i>Trimezia martinicensis</i>	X					
Lemnaceae						
<i>Wolffia columbiana</i>		X				
Liliaceae						
<i>Smilax balbisiana</i>		X				
Musaceae						
<i>Musa sapientum</i>			X			
Orchidaceae						
<i>Bletia florida</i>		X				
<i>Brassia caudata</i>		X				
<i>Broughtonia sanguinea</i>					X	
<i>Campylocentrum barrettiae</i>		X				
<i>Centrogenium setaceum</i>		X			X	
<i>Dendrophylax funalis</i>		X				
<i>Elleanthus longibracteatus</i>		X				
<i>Epidendrum anceps</i>		X				
<i>Epidendrum difforme</i>		X				
<i>Epidendrum diffusum</i>		X				
<i>Epidendrum fragrans</i>		X				
<i>Epidendrum nutans</i> var.						
<i>obtusifolium</i>		X				
<i>Epidendrum polybulbon</i>		X				
<i>Galeandra beyrichii</i>		X				
<i>Govenia utriculata</i>		X				
<i>Habenaria alata</i>		X				
<i>Habenaria quinqueseta</i>		X				
<i>Ionopsis utricularioides</i>		X				
<i>Jacquiniella globosa</i>		X				
<i>Liparis elata</i>		X				
<i>Malaxis spicata</i>		X				
<i>Oncidium luridum</i>		X				
<i>Oncidium tetrapetalum</i>					X	
<i>Oncidium triquetrum</i>		X				
<i>Pleurothallis tribuloides</i>		X				
<i>Polystachya foliosa</i>		X				
<i>Ponthieva ventricosa</i>		X				
<i>Schomburgkia lyonsii</i>		X				
<i>Spiranthes adnata</i>		X				
<i>Spiranthes tortilis</i>		X				
Palmae						
<i>Cocos nucifera</i>				X		
<i>Thrinax parviflora</i>					X	
<i>Thrinax</i> sp.		X				

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
DICOTYLEDONEAE						
Acanthaceae						
<i>Anthacanthus armatus</i>		X			X	
<i>Blechum brownei</i>			X			
<i>Dicliptera assurgens</i>				X		
<i>Salpichantha coccinea</i>		X				
<i>Thunbergia alata</i>	X		X			
<i>Thunbergia fragrans</i>	X	X				
Amaranthaceae						
<i>Achyranthes indica</i>			X			
<i>Amaranthus dubius</i>			X			
<i>Amaranthus polygonoides</i>				X		
<i>Amaranthus spinosus</i>			X			
<i>Celosia nitida</i>					X	
<i>Iresine paniculata</i>		X				
Anacardiaceae						
<i>Anacardium occidentale</i>				X		
<i>Comocladia pinnatifolia</i>		X			X	
<i>Mangifera indica</i>				X		P
<i>Metopium brownei</i>					X	
<i>Spondias purpurea</i>	X					
Annonaceae						
<i>Annona jamaicensis</i>		X			X	
<i>Annona muricata</i>				X		
<i>Xylopia muricata</i>		X			X	
Apocynaceae						
<i>Catharanthus roseus</i>				X		X
<i>Echites umbellata</i>						X
<i>Forsteronia floribunda</i>		X				
<i>Mandevilla torosa</i>					X	
<i>Plumeria obtusa</i>		X	X	X	X	
<i>Rauvolfia tetraphylla</i>					X	
<i>Urechites lutea</i>	X	X	X	X		X
Aquifoliaceae						
<i>Ilex uniflora</i>		X				
Araliaceae						
<i>Dendropanax arboreus</i>		X			X	
<i>Oreopanax capitatum</i>		X				
Asclepiadaceae						
<i>Asclepias curassavica</i>	X		X	X		X
<i>Asclepias nivea</i>	X	X				
<i>Metastelma ephedroides</i>		X			X	
<i>Metastelma filiforme</i>		X				

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
Balanophoraceae						
<i>Scybalium jamaicense</i>		X				
Begoniaceae						
<i>Begonia glabra</i>		X				
<i>Begonia purpurea</i>		X				
Bignoniaceae						
<i>Crescentia cujete</i>	X			X		
<i>Schlegelia parasitica</i>		X			X	
<i>Spathodia nilotica</i>	X			X	X	
<i>Tabebuia angustata</i>		X			X	
<i>Tabebuia riparia</i>					X	
<i>Tecoma stans</i>	X	X		X	X	
Bombacaceae						
<i>Ceiba pentandra</i>	X	X	X	X	X	X
<i>Ochroma pyramidale</i>			X			
Boraginaceae						
<i>Bourreria succulentata</i>					X	
<i>Cordia asperima</i>					X	
<i>Cordia gerascanthus</i>		X				
<i>Cordia globosa</i>	X	X	X	X	X	
<i>Cordia jamaicensis</i>				X	X	
<i>Cordia macrophylla</i>		X				
<i>Cordia martinicensis</i>				X		
<i>Cordia nitida</i>					X	
<i>Ehretia tinifolia</i>				X	X	
<i>Heliotropium angiospermum</i>				X		X
<i>Heliotropium hirsutissimum</i>	X	X		X	X	
<i>Tournefortia hirsutissima</i>	X	X	X			
<i>Tournefortia volubilis</i>				X	X	
Burseraceae						
<i>Bursera simaruba</i>				X	X	
Cactaceae						
<i>Rhipsalis cassytha</i>		X				
<i>Rhipsalis jamaicensis</i>	X	X				
<i>Cereus swartzii</i>					X	
<i>Cereus triangularis</i>					X	
Capparidaceae						
<i>Capparis cynophallophora</i>		X			X	
<i>Capparis ferruginea</i>				X	X	
<i>Cleome gynandra</i>		X	X			
Caprifoliaceae						
<i>Viburnum alpinum</i>		X				
<i>Viburnum villosum</i>		X				

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
Caryophyllaceae						
<i>Drymaria cordata</i>	X					
Celastraceae						
<i>Elaeodendron dioecum</i>		X				
<i>Maytenus jamaicensis</i>		X				
<i>Schaefferia frutescens</i>					X	
Combretaceae						
<i>Terminalia latifolia</i>		X	X			
Compositae						
<i>Ageratum conyzoides</i>			X			
<i>Ambrosia paniculata</i>	X	X	X			
<i>Aster exilis</i>			X			
<i>Bidens cynapiifolia</i>			X			
<i>Bidens pilosa</i>	X		X	X		X
<i>Crepis japonica</i>			X			
<i>Eclipta alba</i>			X			
<i>Elephantopus mollis</i>	X					
<i>Eleutheranthera ruderalis</i>			X			
<i>Emilia sagittata</i>	X		X			
<i>Emilia sonchifolia</i>	X		X	X		
<i>Erechtites hieracifolia</i>			X			X
<i>Erigeron canadensis</i>	X		X	X		X
<i>Eupatorium dalea</i>					X	
<i>Eupatorium macrophyllum</i>		X				
<i>Eupatorium odoratum</i>	X	X	X	X		
<i>Eupatorium parviflorum</i>		X				
<i>Eupatorium villosum</i>	X	X	X	X		X
<i>Lactuca jamaicensis</i>			X			X
<i>Lagascea mollis</i>				X		
<i>Melanthera aspera</i>						X
<i>Mikania cordifolia</i>		X				
<i>Mikania micrantha</i>	X	X	X			
<i>Notoptera hirsuta</i>		X				
<i>Parthenium hysterophorus</i>				X		
<i>Pluchea odorata</i>		X	X			
<i>Porophyllum ellipticum</i>			X			
<i>Pseudelephantopus spicatus</i>		X				
<i>Salmea scandens</i>		X			X	
<i>Sonchus oleraceus</i>			X			
<i>Synedrella nodiflora</i>			X			
<i>Verbesina alata</i>	X		X			X
<i>Verbesina pinnatifida</i>			X			
<i>Vernonia acuminata</i>		X	X			
<i>Vernonia cinerea</i>		X	X			X
<i>Wedelia gracilis</i>	X		X			

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
Connaraceae						
<i>Rourea paucifoliata</i>		X				
Convolvulaceae						
<i>Dichondra repens</i>			X			X
<i>Ipomoea cathartica</i>	X	X	X			
<i>Ipomoea dissecta</i>				X		X
<i>Ipomoea grisebachii</i>		X			X	
<i>Ipomoea ternata</i>		X				
<i>Ipomoea tiliacea</i>	X		X			
<i>Ipomoea triloba</i>						X
<i>Jacquemontia jamaicensis</i>			X			
Crassulaceae						
<i>Bryophyllum pinnatum</i>				X	X	
Cruciferae						
<i>Lepidium virginicum</i>			X			
Cucurbitaceae						
<i>Cionosicyos pomiformis</i>		X		X		
<i>Cucumis anguria</i>		X				
<i>Momordica charantia</i>	X					
Ebenaceae						
<i>Diospyros tetrasperma</i>		X			X	
Elaeocarpaceae						
<i>Sloanea jamaicensis</i>		X				
Erythroxylaceae						
<i>Erythroxylum areolatum</i>					X	
<i>Erythroxylum confusum</i>					X	
<i>Erythroxylum incrassatum</i>		X				
<i>Erythroxylum rotundifolium</i>					X	
Euphorbiaceae						
<i>Acidoton urens</i>	X	X			X	
<i>Alchornea latifolia</i>		X				
<i>Bernardia carpinifolia</i>				X	X	
<i>Croton glabellus</i>					X	X
<i>Croton humilis</i>				X	X	
<i>Croton linearis</i>					X	X
<i>Croton lucidus</i>				X		
<i>Croton wilsonii</i>					X	
<i>Drypetes alba</i>					X	
<i>Drypetes lateriflora</i>		X			X	
<i>Euphorbia geniculata</i>				X		
<i>Euphorbia heterophylla</i>	X			X		X
<i>Euphorbia hirta</i> var. <i>hirta</i>	X		X	X		X

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
<i>Euphorbia hirta</i> var.						
<i>procumbens</i>	X		X			X
<i>Euphorbia hypericifolia</i>					X	
<i>Euphorbia hyssopifolia</i>	X		X		X	X
<i>Euphorbia punicea</i>		X				
<i>Gymnanthes lucida</i>					X	
<i>Manihot utilissima</i>						P
<i>Omphalea triandra</i>		X			X	
<i>Pedilanthus tithymaloides</i>				X		
<i>Phyllanthus coxianus</i>		X				
<i>Phyllanthus inaequalifolius</i>		X				
<i>Phyllanthus montanus</i>					X	
<i>Phyllanthus nutans</i>					X	
<i>Ricinus communis</i>	X		X	X		X
<i>Tragia volubilis</i>					X	
Flacourtiaceae						
<i>Casearia aculeata</i>		X		X	X	
<i>Casearia guianensis</i>	X	X			X	
<i>Casearia hirsuta</i>		X				
<i>Casearia odorata</i>		X				
<i>Casearia sylvestris</i>		X			X	
<i>Laetia thamnina</i>		X			X	
<i>Xylosma fawcettii</i>		X				
Gesneriaceae						
<i>Columnea fawcettii</i>		X				
<i>Columnea</i> sp.					X	
<i>Gesneria acaulis</i>		X				
<i>Rhytidophyllum tomentosum</i>	X	X				
Guttiferae						
<i>Clusia flava</i>		X			X	
<i>Rheedia sessiliflora</i>		X				
Labiatae						
<i>Hyptis capitata</i>	X	X	X			
<i>Hyptis pectinata</i>			X	X		
<i>Leonurus sibiricus</i>		X	X	X		
<i>Ocimum micranthum</i>				X		X
<i>Salvia coccinea</i>					X	X
<i>Salvia micrantha</i>	X				X	
<i>Teucrium vesicarium</i>	X		X			
Lauraceae						
<i>Nectandra antillana</i>		X	X			
<i>Nectandra coriacea</i>		X			X	
<i>Nectandra patens</i>		X				

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
<i>Ocotea floribunda</i>		X				
<i>Ocotea staminea</i>		X			X	
<i>Persea americana</i>			P			
Leguminosae						
<i>Abrus precatorius</i>		X			X	
<i>Adenanthera pavonina</i>		X				
<i>Aeschynomene americana</i>	X	X				
<i>Albizzia berteriana</i>					X	
<i>Andira inermis</i>		X				
<i>Arachis hypogaea</i>						P
<i>Bauhinia divaricata</i>	X	X		X	X	
<i>Caesalpinia sepiaria</i>		X				
<i>Cajanus cajan</i>				X		P
<i>Calliandra portoricensis</i>				X	X	X
<i>Canavalia ensiformis</i>		X				
<i>Cassia ligustrina</i>	X	X	X	X		X
<i>Cassia occidentalis</i>	X		X			X
<i>Cassia siamea</i>			P			P
<i>Cassia uniflora</i>	X			X		X
<i>Centrosema virginianum</i>	X			X		X
<i>Crotalaria incana</i>	X		X			X
<i>Crotalaria retusa</i>						X
<i>Crotalaria verrucosa</i>				X		X
<i>Desmodium axillare</i> var. <i>acutifolium</i>	X	X	X			
<i>Desmodium canum</i>	X		X	X		X
<i>Desmodium scorpiurus</i>				X		X
<i>Desmodium tortuosum</i>				X		
<i>Flemingia strobilifera</i>	X	X				
<i>Galactia pendula</i>					X	
<i>Galactia striata</i>				X		
<i>Haematoxylon campechianum</i>	X	X		X	X	X
<i>Indigofera suffruticosa</i>	X		X	X		X
<i>Leucaena glauca</i>				X	X	
<i>Lonchocarpus domingensis</i>					X	
<i>Mimosa pudica</i>	X		X	X		X
<i>Peltophorum brasiliense</i>		X				
<i>Phaseolus lathyroides</i>	X					
<i>Pueraria lobata</i>			P			
<i>Piscidia piscipula</i>	X	X		X	X	
<i>Pithecellobium alexandri</i>					X	
<i>Pithecellobium arboreum</i>		X			X	
<i>Rhynchosia minima</i>						X
<i>Rhynchosia phaseoloides</i>		X				
<i>Sophora tomentosa</i>						X
<i>Stylosanthes hamata</i>				X		X
<i>Tamarindus indicus</i>				X		

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
Lobeliaceae						
<i>Lobelia viridiflora</i>	X	X	X			
Loganiaceae						
<i>Spigelia anthelmia</i>		X	X			X
Loranthaceae						
<i>Phoradendron latifolium</i>		X				
<i>Oryctanthus occidentalis</i>		X				
Lythraceae						
<i>Cuphea parsonsia</i>			X			
Malpighiaceae						
<i>Bunchosia jamaicensis</i>		X				
<i>Bunchosia media</i>					X	
<i>Bunchosia swartziana</i>		X		X	X	X
<i>Byrsonima coriacea</i>					X	
<i>Malpighia glabra</i>	X	X			X	
<i>Malpighia urens</i>		X				
<i>Mascagnia hiraia</i>					X	
<i>Stigmaphyllon emarginatum</i>				X		
Malvaceae						
<i>Abutilon crispum</i>					X	
<i>Gossypium hirsutum</i>			X			
<i>Hibiscus clypeatus</i>		X			X	
<i>Hibiscus elatus</i>			P			P
<i>Malvastrum spicatum</i>		X				
<i>Malva viscus arboreus</i>		X				
<i>Pavonia rosea</i>		X				
<i>Pavonia spinifex</i>	X					
<i>Sida acuta</i>			X	X		X
<i>Sida cordifolia</i>				X	X	X
<i>Sida glabra</i>				X		
<i>Sida rhombifolia</i>	X		X	X	X	
<i>Sida spinosa</i>				X		
<i>Sida urens</i>	X		X			
<i>Urena lobata</i>	X		X			X
<i>Wissadula amplissima</i>		X		X	X	X
<i>Wissadula fadyenii</i>					X	
Melastomataceae						
<i>Blakea trinervia</i>		X				
<i>Miconia laevigata</i>		X	X			
<i>Ossaea microphylla</i>	X					
<i>Tetrazygia hispida</i>		X				
<i>Tetrazygia pallens</i>		X				
Meliaceae						
<i>Cedrela odorata</i>		X			X	P

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
<i>Guarea glabra</i>	X	X			X	
<i>Melia composita</i>						P
<i>Swietenia mahagoni</i>					X	
<i>Trichilia glabra</i>					X	
<i>Trichilia moschata</i>					X	
Menispermaceae						
<i>Cissampelos pareira</i>	X	X		X	X	
<i>Hyperbaena domingensis</i>		X			X	
<i>Hyperbaena laurifolia</i>		X				
Moraceae						
<i>Artocarpus communis</i>	X			X		P
<i>Artocarpus integrifolia</i>	X	X				
<i>Cecropia peltata</i>	X	X	X		X	
<i>Chlorophora tinctoria</i>		X			X	
<i>Ficus harrisii</i>		X				
<i>Ficus ochroleuca</i>	X	X				
<i>Ficus populnea</i>		X			X	
<i>Ficus suffocans</i>		X	X	X	X	
<i>Ficus wilsoni</i>	X	X				
<i>Trophis racemosa</i>		X				
Myrsinaceae						
<i>Rapanea guianensis</i>					X	
<i>Wallenia grisebachii</i>					X	
<i>Wallenia laurifolia</i>		X		X	X	
Myristicaceae						
<i>Myristica fragrans</i>			P			
Myrtaceae						
<i>Calypttranthes chytraculia</i>		X			X	
<i>Calypttranthes pallens</i>		X			X	
<i>Eugenia axillaris</i>	X	X			X	
<i>Eugenia biflora</i>					X	
<i>Eugenia disticha</i>		X				
<i>Eugenia eperforata</i>		X				
<i>Eugenia isosticta</i>					X	
<i>Eugenia monticola</i>					X	
<i>Pimenta dioica</i>		X	P		X	
<i>Psidium guajava</i>	X	X		X		X
Nyctaginaceae						
<i>Boerhavia diffusa</i>				X		
<i>Boerhavia erecta</i>				X		
<i>Pisonia aculeata</i>					X	
<i>Pisonia discolor</i>					X	
<i>Torrubia fragrans</i>		X			X	

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
Olacaceae						
<i>Schoepfia multiflora</i>		X				
Oxalidaceae						
<i>Oxalis corniculata</i>	X		X			
<i>Oxalis martiana</i>		X				
Papaveraceae						
<i>Bocconia frutescens</i>		X	X			
Passifloraceae						
<i>Passiflora foetida</i> var. <i>hispida</i>	X		X			
<i>Peperomia clusiaefolia</i>					X	
<i>Passiflora perfoliata</i>		X			X	
<i>Passiflora rubra</i>	X	X	X	X	X	
<i>Passiflora suberosa</i>	X	X	X	X		
Phytolaccaceae						
<i>Phytolacca icosandra</i>			X			
<i>Rivina humilis</i>					X	
<i>Trichostigma octandrum</i>		X			X	
Piperaceae						
<i>Peperomia amplexicaulis</i>		X			X	
<i>Peperomia clusiaefolia</i>					X	
<i>Peperomia glabella</i>		X				
<i>Peperomia rotundifolia</i>	X					
<i>Peperomia serpens</i>		X				
<i>Piper aduncum</i>	X	X	X			
<i>Piper amalago</i>			X	X		
<i>Piper arboreum</i>		X				
<i>Piper jamaicense</i>		X	X			
<i>Piper umbellatum</i>	X		X			
Plumbaginaceae						
<i>Plumbago scandens</i>				X		
Polygalaceae						
<i>Polygala paniculata</i>	X		X			
<i>Securidaca brownei</i>		X				
Polygonaceae						
<i>Coccoloba diversifolia</i>					X	
<i>Coccoloba longifolia</i>		X				
<i>Coccoloba plumieri</i>		X				
<i>Coccoloba proctori</i>					X	
<i>Coccoloba swartzii</i>		X			X	
<i>Coccoloba tenuifolia</i>					X	
<i>Coccoloba uvifera</i>			X	X		
<i>Polygonum glabrum</i>	X	X				

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
Portulacaceae						
<i>Talinum triangulare</i>				X		
Ranunculaceae						
<i>Clematis dioica</i>		X	X		X	
Rhamnaceae						
<i>Colubrina ferruginosa</i>		X		X	X	
<i>Gouania lupuloides</i>			X			
<i>Krugiodendron ferreum</i>					X	
<i>Rhamnus sphaerosperma</i>		X	X			
<i>Sarcomphalus laurinus</i>				X	X	
<i>Zizyphus chloroxylon</i>		X				
Rosaceae						
<i>Prunus myrtifolia</i>		X			X	
<i>Rubus jamaicensis</i>	X		X			
Rubiaceae						
<i>Antirrhoea jamaicensis</i>		X				
<i>Borreria laevis</i>	X		X	X		X
<i>Borreria verticillata</i>	X	X	X	X		X
<i>Casasia longipes</i>				X	X	
<i>Casasia piricarpa</i>		X				
<i>Chiococca alba</i>		X			X	
<i>Chiococca parvifolia</i>		X			X	
<i>Coffea arabica</i>	X					
<i>Erithalis quadrangularis</i>		X				
<i>Exostema caribaeum</i>					X	
<i>Guettarda argentea</i>		X				
<i>Guettarda elliptica</i>					X	
<i>Hamelia chrysantha</i>		X			X	
<i>Hamelia cuprea</i>		X				
<i>Hamelia patens</i>		X				
<i>Hamelia ventricosa</i>		X				
<i>Hillia tetrandra</i>		X				
<i>Palicourea domingensis</i>		X				
<i>Portlandia grandiflora</i>					X	
<i>Portlandia microsepala</i>		X				
<i>Psychotria balbisiana</i>					X	
<i>Psychotria dura</i>		X				
<i>Psychotria fadyenii</i>		X				
<i>Psychotria myrstiphyllum</i>					X	
<i>Psychotria nervosa</i>	X	X				
<i>Psychotria patens</i>		X				
<i>Psychotria pedunculata</i>	X	X				
<i>Psychotria pubescens</i>	X	X				
<i>Richardia brasiliensis</i>						X
<i>Rondeletia polita</i>		X				

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
<i>Rondeletia trifolia</i>					X	
<i>Schradera involucrata</i>		X				
Rutaceae						
<i>Amyris elemifera</i>				X		
<i>Amyris plumieri</i>					X	
<i>Citrus aurantifolia</i>				X		P
<i>Citrus vulgaris</i>	X	X		X	X	
<i>Esenbeckia pentaphylla</i>		X		X	X	
<i>Spathelia sorbifolia</i>					X	
<i>Zanthoxylum elephantiasis</i>		X				
<i>Zanthoxylum flavum</i>				X	X	X
<i>Zanthoxylum insulare</i>		X			X	
<i>Zanthoxylum martinicense</i>	X	X	X	X		
Sapindaceae						
<i>Allophylus cominia</i>	X	X			X	
<i>Allophylus jamaicensis</i>		X				
<i>Blighia sapida</i>				X		
<i>Cardiospermum grandiflorum</i>	X	X				
<i>Cardiospermum microcarpum</i>		X				
<i>Cupania glabra</i>		X	X	X	X	
<i>Dodonaea viscosa</i>				X		
<i>Exothea paniculata</i>		X		X	X	
<i>Hypelate trifoliata</i>					X	
<i>Paullinia jamaicensis</i>		X	X			
Sapotaceae						
<i>Chrysophyllum cainito</i>	X					
<i>Dipholis nigra</i>		X			X	
<i>Dipholis salicifolia</i>		X		X	X	X
<i>Manilkara zapotilla</i>		X		X		
<i>Pouteria multiflora</i>		X				
Simarubaceae						
<i>Picramnia antidesma</i>		X		X	X	
<i>Picramnia pentandra</i>					X	
<i>Picrasma excelsa</i>					X	
<i>Simaruba glauca</i>		X		X	X	
Solanaceae						
<i>Brunfelsia americana</i>		X				
<i>Brunfelsia jamaicensis</i>		X			X	
<i>Capsicum baccatum</i>	X				X	
<i>Capsicum frutescens</i>		X				
<i>Cestrum diurnum</i>		X	X			
<i>Physalis pubescens</i>	X		X			
<i>Solandra grandiflora</i>		X				

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
<i>Solanum bahamensis</i> var.						
<i>subarmata</i>				X	X	
<i>Solanum ciliatum</i>			X			
<i>Solanum havanense</i>					X	
<i>Solanum jamaicense</i>			X			
<i>Solanum mammosum</i>	X					
<i>Solanum nigrum</i>	X		X			
<i>Solanum stellatum</i>	X		X			
<i>Solanum torvum</i>	X		X	X	X	X
<i>Solanum verbascifolium</i>	X		X	X		
Sterculiaceae						
<i>Ayenia pusilla</i>				X		
<i>Cola acuminata</i>	X					
<i>Guazuma ulmifolia</i>				X	X	
<i>Helicteres jamaicensis</i>					X	X
<i>Melochia pyramidata</i>				X		X
<i>Theobroma cacao</i>	X				X	
<i>Waltheria americana</i>			X	X		X
Theaceae						
<i>Ternstroemia hartii</i>		X				
Thymelaeaceae						
<i>Daphnopsis americana</i>	X	X			X	
Tiliaceae						
<i>Corchorus siliquosus</i>		X	X			X
<i>Muntingia calabura</i>		X				
<i>Triumfetta hispida</i>	X		X			
<i>Triumfetta lappula</i>	X			X		
Turneraceae						
<i>Piriqueta cistoides</i>						X
Ulmaceae						
<i>Celtis swartzii</i>		X		X	X	X
<i>Celtis trinervia</i>		X				
Umbelliferae						
<i>Apium leptophyllum</i>	X					
<i>Eryngium foetidum</i>	X	X				
<i>Hydrocotyle asiatica</i>	X	X	X			
Urticaceae						
<i>Boehmeria jamaicensis</i>		X				
<i>Pilea brevistipula</i>		X				
<i>Pilea crassifolia</i>		X				
<i>Pilea hollickii</i>		X				

	REYNOLDS			KAISER		
	TO BE MINED	AD- JACENT	IN- VADERS	TO BE MINED	AD- JACENT	IN- VADERS
<i>Pilea microphylla</i>	X	X	X			
<i>Urera expansa</i>		X				
Verbenaceae						
<i>Citharexylum spinosum</i>	X	X		X	X	
<i>Lantana angustifolia</i>					X	
<i>Lantana camara</i>	X	X	X	X		
<i>Lantana reticulata</i>				X	X	X
<i>Lantana trifolia</i>	X		X			
<i>Petitia domingensis</i>	X	X	X			
<i>Phyla nodiflora</i>	X		X			
<i>Phyla stoechadifolia</i>	X					
<i>Priva lappulacea</i>	X		X	X		X
<i>Stachytarpheta cayennensis</i>			X			
<i>Stachytarpheta jamaicensis</i>	X	X	X	X		X
<i>Tectona grandis</i>						P
Vitaceae						
<i>Cissus microcarpa</i>	X	X				
<i>Cissus sicyoides</i>	X	X	X			
Zygophyllaceae						
<i>Kallstroemia maxima</i>						X

ARNOLD ARBORETUM

AND

THE INSTITUTE OF JAMAICA

A MONOGRAPHIC STUDY OF THE WEST INDIAN SPECIES OF *PHYLLANTHUS* *

GRADY L. WEBSTER

With three plates

Subgenus IV. *Phyllanthus*.

Herbs or undershrubs with phyllanthoid branching and relatively small leaves. Monoecious or dioecious; female flowers solitary, male flowers solitary or in axillary cymes. Male flower: calyx-lobes 5 or 6; disk of 5 or 6 segments; stamens 2 or 3, free or united; anthers dehiscing vertically to horizontally; pollen grains various. Female flower: calyx-lobes 5 or 6; disk cupuliform or divided into 5 or more segments; ovary of 3 carpels, smooth or roughened; styles bifid, mostly free. Fruit capsular, often explosively dehiscent; seeds trigonous, 2 in each locule, mostly ribbed or verruculose.

This subgenus, as here defined, comprises a part of sections *Paraphyllanthus* and *Euphyllanthus* sensu Mueller, and includes the majority of the herbaceous species in the genus. It is certainly a heterogeneous group and possibly a polyphyletic one, the various herbaceous representatives perhaps having evolved from different shrubby ancestors; but in the absence of any pertinent evidence to the contrary, the following four West Indian sections seem best grouped together.

It must be admitted that the demarcation of this, the typical subgenus, is the most unsatisfactory of any of the subgeneric divisions of *Phyllanthus*. At present it is most difficult to decide whether a number of puzzling Old World groups, such as the Indo-Chinese species of sections *Emblica* and *Paraphyllanthus* (sensu Beille, Fl. Gen. Indo-Ch. 5: 572-573. 1927), should be included or not. These plants, being mostly trees and shrubs, do not clearly fit into subg. *Phyllanthus*, but there does not appear to be any other very satisfactory place to put them. In the West Indies, however, members of subg. *Phyllanthus* can be easily recognized by their herbaceous habit and reduced male flowers.

KEY TO THE SECTIONS

1. Ovary smooth or papillose; seeds mostly verruculose or longitudinally ribbed, never transversely ribbed or foveolate; leaf-blades never hispidulous (margins crenulate in sect. *Callitrichoides*).
2. Disk or calyx purplish-tinged, or else ovary papillose; flowers entirely solitary; pollen grains not colpate.
3. Stamens connate by the filaments but anthers free; leaves crisply succulent; pollen grains banded 8. *Callitrichoides*

* Continued from volume XXVIII, p. 80.

3. Stamens completely connate into a circumscissile synandrium; leaves not succulent; pollen grains foveolate 9. *Cyclanthera*
2. Disk or calyx never purplish, sometimes reddish-tinged; ovary smooth; male flowers not solitary (except in *P. mimicus*, which has free stamens); pollen grains colporate 11. *Phyllanthus*
1. Ovary bullate-rugose; seeds transversely ribbed and often foveolate on the sides; leaf-blades hispidulous beneath near the margins 10. *Urinaria*

Sect. 8. *Callitrichoides* Webster, Contr. Gray Herb. 176: 51. 1955.

Small herbs with the habit of species of *Callitriche* and *Peperomia*, tissues crisp-succulent; branching phyllanthoid, the primary axis short, bearing crowded, spreading branchlets, these often rooting at the nodes; leaves of branchlets distichous, with crenate-cartilaginous margins. Monoecious; flowers solitary, most branchlets with 1-4 male flowers and a single distal female flower near the tip. Male flower: calyx-lobes 5, obovate, acute; disk-segments 5, reniform, purplish; stamens 2, filaments completely united, anthers discrete but sessile atop the column, dehiscing horizontally; pollen grains spheroidal, appearing banded due to the transversely elongated areoles.¹³ Female flower: calyx-lobes 6, oblong or spatulate; disk-segments 6, narrowly cuneate, purplish; ovary densely scabridulous; styles ascending, emarginate or bifid. Capsule small, densely scabridulous; seeds brownish, verruculose with scattered dark points.

TYPE SPECIES: *Phyllanthus carnosulus* Muell. Arg.

The type species, a rare plant endemic to eastern Cuba, is the sole representative of this interesting monotypic section. Its unique habit at once distinguishes it from all its North American congeners. Although Mueller placed it in the alliance of *P. heliotropus*, *P. hyssopifolioides*, et al. (now in sect. *Loxopodium*), it is not at all closely related to these. Its nearest affinity is undoubtedly with the species of sect. *Cyclanthera*, which (as pointed out below) have either been derived from sect. *Callitrichoides* or from some common ancestor.

Although there can be little doubt that sects. *Callitrichoides* and *Cyclanthera* are closely allied (so closely, in fact, that the two could perhaps be treated as subsections of a common section), it is not at all clear from what other group in the genus these two highly specialized sections might have been derived. The ancestral group certainly was not any of the taxa in sect. *Phyllanthus*, none of which shows a close relationship. The peculiar pollen of sect. *Callitrichoides* is found nowhere else in the genus and has a counterpart only in *Andrachne brittonii*. The latter also has very small somewhat succulent leaves; but it differs in many important details, such as its woody xerophytic habit with spiny branch-tips and its petaliferous flowers, so that its resemblance to *P. carnosulus* must be ascribed to an interesting case of parallelism.

¹³ See Plate IX, fig. 39.

Perhaps sect. *Loxopodium* comes closest to being a likely progenitor, so that Mueller's placement of *P. carnosulus* among the species of that group was not entirely without merit. The leaves and stipules of sect. *Callitrichoides* are certainly similar to those of various representatives of *Loxopodium*, and the free cuneate disk-segments of the female flower — as well as several other floral details — are suggestively alike in both groups. However, to suggest that sect. *Callitrichoides* did evolve from some representative of sect. *Loxopodium* involves the assumption that the phyllanthoid branching of this section has evolved independently of that in sect. *Phyllanthus*. Since a similar assumption appears necessary in the case of sect. *Urinaria*, it thus is quite possible that phyllanthoid branching has originated independently three times within subg. *Phyllanthus*.

11. *Phyllanthus carnosulus* Muell. Arg. Linnaea 32: 30. 1863; DC. Prodr. 15(2): 388. 1866. (PLATE XVI, figs. A–E).

Diasperus carnosulus (Muell. Arg.) O. Ktze. Rev. Gen. 2: 598. 1891.

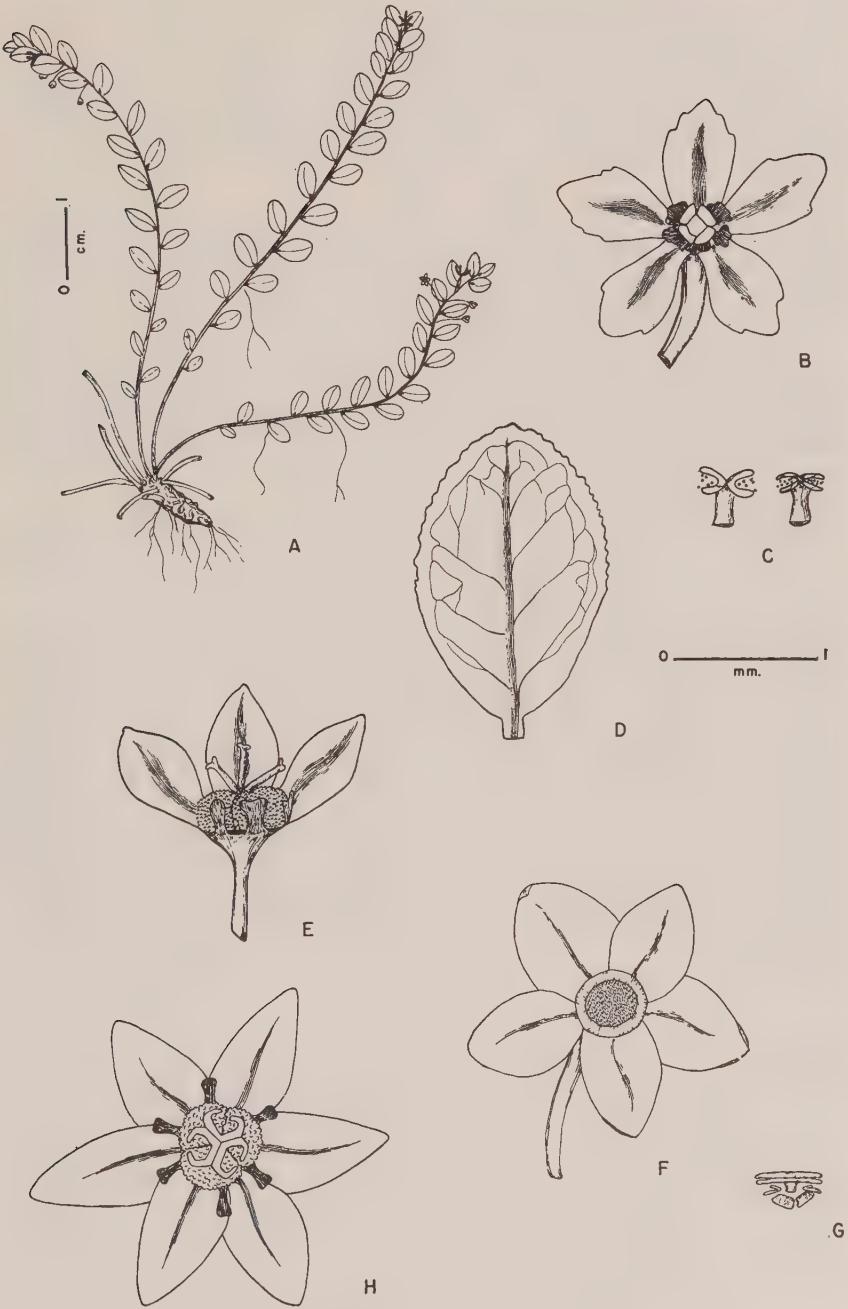
Phyllanthus haplocladus Urb. Repert. Sp. Nov. 28: 214. 1930.

Low perennial herb with crisply and slightly succulent branches and leaves, the habit like that of a small *Peperomia* or *Pilea*; primary axis becoming a slender dark brown rootstock c. 0.5–1 cm. long and 1.5–4 mm. thick, bearing stubs of old branches below. Cataphylls scarious, brownish; stipules triangular-ovate, denticulate or lacerate towards the acute or acuminate tip, up to 0.8 mm. long and 0.6 mm. broad; blade narrower. Deciduous branchlets crowded at apex of rootstock, spreading or prostrate, sometimes rooting at the nodes, (3–) 5–8 (–15) cm. long, 0.2–0.6 mm. thick, stramineous, minutely papillate-scabridulous, angled, furrowed when dried, with c. (10–) 25–40 (–50) leaves; first internode usually 1 cm. long or more, median internodes mostly 1–3.5 (–6) mm. long. Leaves: stipules ovate-triangular to lanceolate, acute or acuminate, somewhat dilated at the basal corners but not distinctly auriculate, denticulate or nearly entire, at first thin and olivaceous or reddish-tinged, at length firmer, the midrib dark brownish, the margins scarious, 0.5–0.9 mm. long, 0.3–0.6 (–0.7) mm. broad. Petioles 0.2–0.4 mm. long, flattened, smooth. Blade obovate to elliptic or oblong, rounded or obtuse and apiculate at the tip, acute to obtuse at the base, (2–) 3.5–6 (–7) mm. long, 1.5–4 mm. broad; above olivaceous, rugulose-reticulate, the midrib, laterals and anastomosing tertiary veinlets slightly raised; beneath pallid, dull reddish, obscurely scabridulous, the midrib prominent but second-

PLATE XVI. Sections *Callitrichoides* and *Cyclanthera*.

FIGS. A–E. *Phyllanthus carnosulus* Muell. Arg. A. habit (Ekman 16090 [S]); B, male flower; C, androecium seen from one side (left) and facing an anther (right); D, leaf; E, female flower with three calyx-lobes removed (Wright "714" [GOET]).

FIGS. F–H. *Phyllanthus tenuicaulis* Muell. Arg. (Wright 1675). F, male flower; G, androecium and disk seen from the side; H, female flower. (Figs. B–H drawn to the same scale.)



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ary veins obscure; margin usually unevenly cartilaginous-thickened, or more less regularly cartilaginous-toothed beyond the middle.

Monoecious, but male flowers readily deciduous and specimens thus sometimes appearing entirely female. Flowers strictly solitary in the distal axils of the branchlet; most often the males 2-4 on a branchlet and the single female flower distal to them (but female flower sometimes proximal).

Male flower: pedicel capillary, mostly 2.5-5 mm. long. Calyx-lobes 5, narrowly elliptic to obovate, c. 0.7-0.8 mm. long, 0.4-0.5 mm. broad, acute, entire or obscurely denticulate, membranous, yellowish with a scarious margin, thin, the midrib somewhat raised without but plane within, unbranched. Disk-segments 5, more or less reniform, c. 0.25-0.35 mm. broad and 0.15-0.2 mm. long, distinctly purple, subentire, smooth and not evidently pitted. Stamens 2; filaments completed fused into a column c. 0.2-0.3 mm. high; anthers sessile atop the column and contiguous but discrete, 0.25-0.3 mm. broad, dehiscing horizontally, the anther-sacs not confluent; pollen grains spherical, c. 15 μ in diameter, banded by ribbon-shaped areoles.

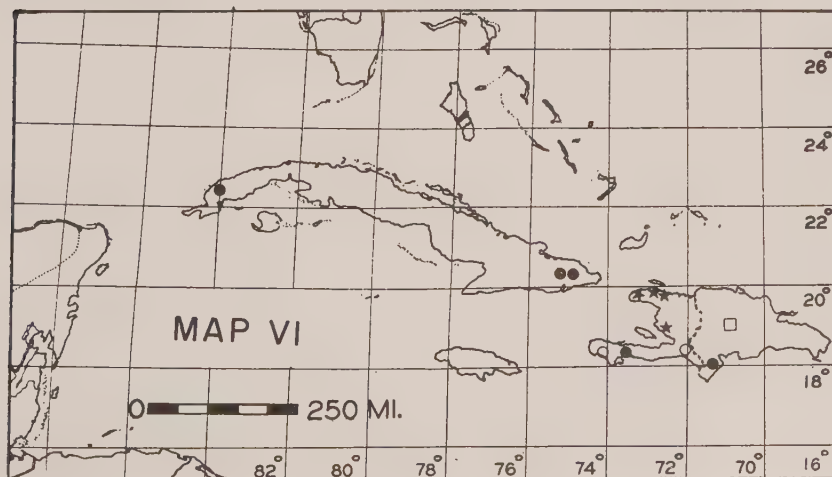
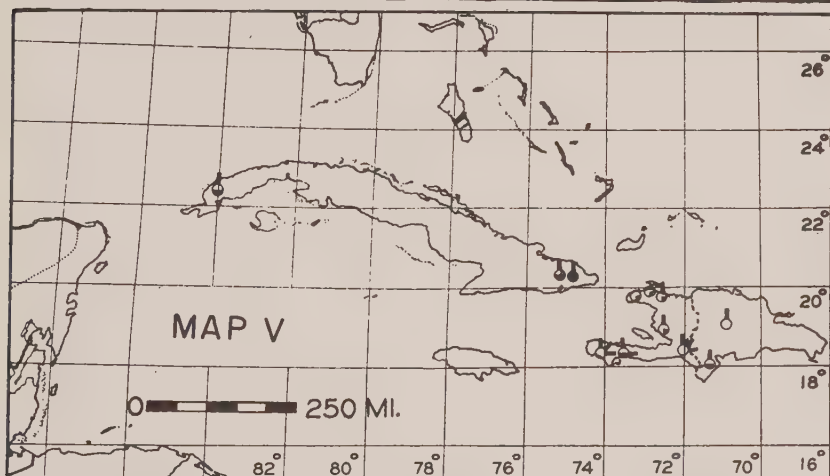
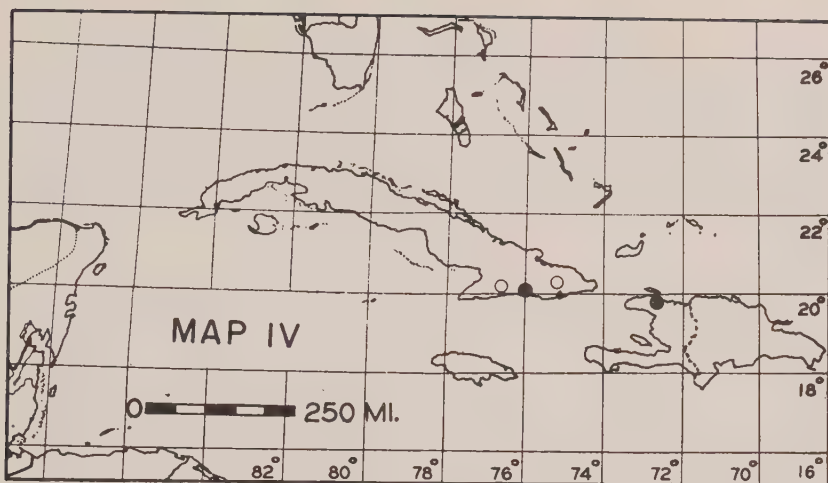
Female flower: pedicel straight, terete, smooth, c. 1-1.7 mm. long. Calyx-lobes 6, narrowly oblong to spatulate, 0.8-0.9 mm. increasing to 1-1.4 mm. long, 0.35-0.7 mm. broad, acute or obtuse, olivaceous with scarious margins; midrib slightly raised without and (at the base) within, unbranched. Disk-segments 6, completely separate, c. 0.2-0.25 mm. long, cuneate (often narrowly so) from a stipitate base, expanded to a truncate, emarginate, or bifurcate tip, distinctly purplish, subcarinose, smooth and entire. Ovary oblate, c. 0.3 mm. high and twice as broad, densely but minutely papillate-scabridulous. Styles free, erect or ascending, c. 0.3 mm. long, emarginate to shortly bifid, slender, the tips spreading to recurved.

Capsule c. 1.5 mm. in diameter when mature, breaking up readily, the thin valves yellowish brown, scurfy-roughened, not nervose. Seeds 0.7-0.75 mm. long, 0.55-0.6 mm. radially, 0.6-0.7 mm. tangentially, fuscous, plumply trigonous, granulate with evenly spaced raised dark points.

MAP IV. Distribution of *Phyllanthus carnosulus* Muell. Arg. (open circles) and *Phyllanthus tenuicaulis* Muell. Arg. (solid circles).

MAP V. Distribution of certain taxonomic characters among the populations of *Phyllanthus lindenianus* Baill. Open circles indicate plants completely smooth; scabridulosity is indicated by blackening portions of circles as follows: southeast quadrant, female pedicel; southwest quadrant, stem; northwest quadrant, female calyx; northeast quadrant, leaf. Erect bar indicates presence of iterative axes on branchlets (at least in part); oblique bar signifies marked inequality of leaf size; horizontal bar denotes perennial habit.

MAP VI. Distribution of the varieties recognized within *Phyllanthus lindenianus*: var. *inaequifolius*, open circles; var. *jimenezii*, square; var. *leonardorum*, stars; var. *lindenianus*, solid circles.



TYPE: "Cuba orientali," *Wright 591* (G, HOLOTYPE). According to the data associated with the isotype specimen in the New York Botanical Garden Herbarium, this number was collected at Monte Toro. In the packet of the Gray Herbarium sheet on which *Wright 591* is mounted are three labels with the localities: "La Luisa in Monte Toro," "Potosí Mt. Liban," and "Potosí Monte Toro"; however, it is not clear whether these belong with no. 591 or with *Wright 1939*, which is also mounted on the sheet.

DISTRIBUTION: endemic to the mountainous parts of Oriente Province, Cuba (MAP IV).

CUBA. ORIENTE: Sierra Maestra, southeast of Bayamo, in the rocky shrub forest at the base of an enormous stone ("El diente del Gigante"), on top of Loma del Gigante, alt. c. 1200 m., *Ekman 16090* (NY, S; type collection of *P. haplocladus*). "Cuba orientali" [i.e., Sagua-Baracoa range], *Wright 591* (G, HOLOTYPE; BR, GH, NY, ISOTYPES), *1939* (G, GH, GOET, MO, S, W), "530", "714", (GOET, these being field numbers and presumably corresponding to either 591 or 1939).

This remarkable little plant, though apparently quite rare, may be encountered by future collectors in the wetter parts of both the Sierra Maestra and the Sagua-Baracoa range. On his manuscript notes quoted above, Wright gave the habitat data for the species as "base of cliffs," "margins of mountain-rivulets," and "dense woods," respectively. The habit of the plant leaves no doubt that it is quite hydrophilic, and from the debris clinging to the specimens one can infer that it grows in rain-forest areas on marly banks, often associated with mosses and liverworts. Dr. Howard Crum kindly identified the moss associated with *Ekman 16090* as *Phyllogonium fulgens*, and the two with *Wright 591* and "714" as *Trichostomum jamaicense* and *Thuidium urceolatum*, respectively.

As far as can be judged from examination of the relatively few collections, *P. carnosulus* is a rather homogeneous species. Although there is some variation in length and number of leaves per branchlet, as well as in other respects, there is no evidence that the Sierra Maestra population deserves any special subspecific designation. Urban, in fact, appears to have overlooked the fact that Mueller had already described the species, for when proposing *P. haplocladus* as a new species he said nothing about its relationships. Urban's description is misleading in that he reported the plant to be annual and probably dioecious. However, several of the plants of the type collection (*Ekman 16090*) are obviously more than one year old; evidently the species is a perennial which may flower the first year. Nor is it likely that plants of *P. carnosulus* are ever dioecious; but the male flowers are readily deciduous, so that older specimens sometimes give the appearance of bearing only female flowers.

The slightly succulent leaves with cartilaginous "toothing," the adventitious roots, the solitary flowers with purplish disk-segments (described as "dark red" in the living condition by Wright), and the unique pollen grains distinguish *P. carnosulus* from all its congeners. However,

it is clearly more closely related to *P. tenuicaulis* of the following section than to any other species; the two plants show a near affinity through the common possession of a very small papillose capsule, in addition to the several characters that the other species of sect. *Cyclanthera* share with *P. carnosulus*. It appears reasonable to conclude, therefore, that the species of sect. *Cyclanthera* have been derived from sect. *Callitrichoides* via *P. tenuicaulis* or some very similar form.

Sect. 9. *Cyllanthera* Webster, Contr. Gray Herb. 176: 47. 1955.

Annual or perennial herbs or low subshrubs, with phyllanthoid branching; deciduous branchlets often with a smaller iterative axis¹⁴ from the first node, and leaves of upper branchlets often much smaller than those below. Monoecious or dioecious; flowers entirely solitary, in axils on both axes of branchlet. Male flower: calyx-lobes 5 or 6; disk-segments 5 or 6, purplish; stamens 3, filaments connate into a column, anthers completely coalescent into a disciform circumscissile synandrium; pollen grains globose, foveolate.¹⁵ Female flower: calyx-lobes 6; disk of 3–8 lobes, usually purplish; ovary smooth or scabridulous; styles bifid, free or united. Capsule smooth or scabridulous; seeds verruculose.

TYPE SPECIES: *Phyllanthus lindenianus* Baill.

This very distinctive section of eight specific and subspecific taxa is endemic to Cuba and Hispaniola. As pointed out in the original description, the section is strongly characterized by the remarkable modification of the androecium, the unique pollen grains somewhat resembling those of *Polygonum* sect. *Persicaria*, and the common production of an extra ("iterative") leafy axis from the first node of the deciduous branchlet. The only clearly related group, sect. *Callitrichoides*, is believed to be ancestral to the present section because of its less specialized androecium. If this is correct, then the "foveolate" ornamentation of the pollen grains of *Cyclanthera* has presumably been derived through modification of the "banded" pollen grain of *Callitrichoides* (cf. Plate IX, figs. 39 and 40).

The vegetative peculiarities of sections *Callitrichoides* and *Cyclanthera* are of particular interest in considerations of both phylogeny and the origin of phyllanthoid branching. In sects. *Urinaria* and *Phyllanthus* the branchlets produce at the nodes only flowers or floral axes; but in sect. *Callitrichoides* roots can be formed at branchlet nodes, and in sect. *Cyclanthera* all of the species except *P. berteroi* produce a second leafy axis (iterative branchlet) from the first node of each branchlet. Furthermore, in sect. *Cyclanthera* the leaves of the upper part of the stem are often strikingly smaller than those of the lower part. These specializations provide evidence favorable to the hypothesis that phyllanthoid branching has originated independently in three different lines within subg. *Phyllanthus*.

¹⁴ See Plate XVII, fig. A.

¹⁵ See Plate IX, fig. 40.

From a phytogeographic point of view, sect. *Cyclanthera* is noteworthy in having its center of distribution in Hispaniola. Of the eight named taxa of the section, seven occur in Hispaniola and six are endemic there, while only two taxa are found in Cuba, and only the typical variety of *P. tenuicaulis* is endemic there. However, when one considers the origin of the section, Cuba assumes a relatively more important position, since the ancestral sect. *Callitrichoides* is confined to Oriente Province. Perhaps the origin of sect. *Cyclanthera* may be referred to that period in the Cenozoic when eastern Cuba and Hispaniola formed a single land-mass.

The following treatment of the eight constituent taxa of sect. *Cyclanthera* must be considered only provisional, and the lack of field observations is keenly felt. A satisfactory treatment does not appear possible until further collecting is done and the possibility of hybridization taken into account.

KEY TO THE SPECIES

1. Leaves of main axis not reduced to cataphylls except at uppermost nodes, mostly coriaceous; deciduous branchlets never with iterative axes; disk-segments petaloid, extending far outside the margins of the synandrium; pedicel of female flower mostly 6–10 mm. long or more; seeds 1.8–2.3 mm. long; northern Hispaniola 14. *P. berterioanus*
1. Leaves of main axis reduced to cataphylls; deciduous branchlets often with iterative axes; disk-segments inconspicuous, not projecting far beyond the synandrium; pedicel of female flower 5 mm. long or less; seeds not over 1.4 mm. long.
 2. Capsule minutely scabridulous, c. 1.5 mm. in diameter; calyces greenish white or purplish only at the base; slender annual with nearly smooth, greenish (never purplish) branchlets; Cuba and northern Haiti 11. *P. tenuicaulis*
 2. Capsule smooth, 2 mm. or more in diameter; calyces usually purplish-stained.
 3. Synandrium subsessile, the column less than 0.3 mm. high; calyx-lobes of male flower free to the base; styles free; habit various; Cuba and Hispaniola 12. *P. lindenianus*
 3. Column of synandrium c. 0.7 mm. high; calyx-lobes of male flower united into a turbinate cup; styles united into a column 0.15–0.2 mm. high; subshrub with clustered stems and membranous leaves; southwestern Haiti 13. *P. abditus*
11. *Phyllanthus tenuicaulis* Muell. Arg. Linnaea 32: 44. 1863; DC. Prodr. 15(2): 409. 1866, (PLATE XVI, figs. F–H).
Diasperus tenuicaulis (Muell. Arg.) O. Ktze. Rev. Gen. 2: 601. 1891.

A very slender herb with an erect simple or sparingly branched stem 1–3 dm. high, 1 mm. thick or less, stramineous or greenish, terete, nearly smooth. Cataphylls thin and scarious, greenish white with an olivaceous tinge; stipules lanceolate, acute or acuminate, more or less obliquely attached but not auriculate, entire, 0.4–0.6 mm. long, 0.2–0.3 mm. broad; blade linear-lanceolate, entire, 0.4–0.7 mm. long, c. 0.15 mm. broad. Permanent branches mostly suppressed. Deciduous branchlets simple or producing an iterative axis from the first node, 1–3.5 cm. long, 0.1–0.2 mm. thick, stramineous, smooth or very obscurely scabridulous proximally, terete or somewhat angled, with 7–20 leaves; first internode 3–7 (–9) mm. long, median ones c. 1.5–3 (–4) mm. long. Leaves: stipules ovate to lanceolate, 0.4–0.5 mm. long, 0.2–0.25 mm. broad, acuminate, truncate at the base, entire, olivaceous with pale scarious margins. Petioles smooth, 0.3–0.5 mm. long. Leaf-blades membranous, obovate to elliptic or sub-orbicular, (3–) 4–8 (–11) mm. long, (1.5–) 2–4 mm. broad, mostly sub-truncate or rounded and apiculate at the tip, acute at the base; above deep green, the nerves rather obscure; beneath pruinose, smooth or appearing roughened when young, the midrib slightly raised, the laterals obscure or visible and anastomosing; margin not thickened, smooth or sometimes crinkled.

Monoecious; flowers solitary, branchlets often with 1 to 2 female flowers toward the tip, the male flowers proximal or sometimes also distal to them; sometimes male and female flowers apparently on separate branchlets (due to the fugaciousness of the male flowers).

Male flower: pedicel capillary, 1.7–3.3 mm. long. Calyx-lobes 5 (rarely 6), ovate or triangular, 0.5–0.9 mm. long, 0.3–0.8 mm. broad, sharply acute, entire, thin, scarious-hyaline, entirely yellowish white or sometimes purplish-blotched at the base (never with purplish midrib or scattered flecks). Disk-segments 5, cuneate, c. 0.2–0.25 mm. broad, with a rather fleshy fold at the base but thin and subpetaloid distally, more or less hidden under the nearly sessile synandrium. Synandrium disciform, 0.3 mm. broad across the connective; pollen grains c. 13–14 μ in diameter.

Female flower: pedicel slender, straight or slightly curved, smooth, olivaceous, 1–2.2 mm. long. Calyx-lobes 6, elliptic to ovate, 0.9–1 mm. long, 0.45–0.6 mm. broad, acute, entire, olivaceous with broad yellowish white scarious margins, sometimes purple-blotched at the base (never purple-flecked all over). Disk-segments 6, thin, hyaline, c. 0.25 mm. long, cuneate, smooth, entire. Ovary closely and minutely scabridulous. Styles free, horizontally spreading, 0.15–0.2 mm. long, bifid or c. 2/3-parted, the branches spreading, the unthickened tips recurved.

Capsule scabridulous, c. 1.5 mm. in diameter, the valves thin, stramineous, nervation obscure. Seeds [all those observed immature] c. 0.75 mm. long, 0.5 mm. radially, marked with dark raised points.

The species comprises two vicarious populations, one Cuban and one Haitian, which differ in the characters mentioned in the following synopsis:

11a. *Phyllanthus tenuicaulis* var. *tenuicaulis*.

Deciduous branchlets c. 1–3.5 cm. long, with 7–11 leaves; leaves obovate, (3–) 4–7 (–11) mm. long; calyx-lobes of male flower 0.5–0.7 mm. long; pedicel of female flower c. 1–1.2 mm. long.

TYPE: "Cuba Orientali," *Wright 1675 ex p.*

DISTRIBUTION: endemic to eastern Cuba (Map IV).

CUBA. ORIENTE: Sierra Maestra. La Madelena, on banks, Dec. 9, 1859, *Wright 1675 ex p.* (G, HOLOTYPE; GH, GOET, NY, W, ISOTYPES); Sierra Maestra, Loma del Gato, *Clemente 597* (NY), *2065* (MICH).

11b. *Phyllanthus tenuicaulis* var. *haitiensis* Webster, Contr. Gray Herb. 176: 48. 1955.

Deciduous branchlets usually 3–5 cm. long, with 13–20 leaves; leaves elliptic or broadly obovate, or nearly orbicular, 4–8 mm. long, 2.5–4 mm. broad; calyx-lobes of male flower c. 0.9 mm. long; pedicel of female flower c. 2 mm. long.

TYPE: Haiti, *Ekman H4417*.

DISTRIBUTION: endemic to northern Haiti (MAP IV).

HAITI. NORD-OUEST: Massif du Nord, Anse-à-Foleur, Morne Cheneau, highest part of ridge, c. 800 m. alt., 25 June 1925, *Ekman H4417* (S, HOLOTYPE); Riv. Côte de Fer, vicinity of Jean Rabel, in crevice of rock, *E. C. & G. M. Leonard 12630* (US).

The specimen of the Leonards is referred to this variety and indeed to the species with some doubt. The ovary appears not to be scabridulous, and judging from the calyx-lobes, the plant resembles *P. lindenianus* var. *leonardorum*. At the present time it is impossible to tell whether the variability present in the five known collections of *P. tenuicaulis* is due to hybridization or to other factors.

Among the species of sect. *Cyclanthera*, *P. tenuicaulis* is of especial interest because it undoubtedly is the species most closely related to sect. *Callitrichoides*; the small scabridulous capsule common to both *P. tenuicaulis* and *P. carnosulus* appears to be an unmistakable mark of affinity. On the other hand, however, the androecium of *P. tenuicaulis* is quite typical for sect. *Cyclanthera*, and the species shows several points of resemblance to some of the varieties of *P. lindenianus*.

12. *Phyllanthus lindenianus* Baill. Adansonia 2: 13. 1861.

Phyllanthus cyclanthera sensu Mueller in DC. Prodr. 15 (2): 408. 1866.

Variable annual or perennial herb, sometimes suffruticose, 0.5–7 dm. high, with a single main stem or with several stems clustered at the base; stems terete, smooth or scabridulous, olivaceous and more or less purplish-

tinged, internodes mostly 8–20 mm. long. Leaves of stems and permanent branches reduced to cataphylls: stipules triangular or lanceolate, usually acuminate, truncate at the base, entire, thin and scarious, purple or purplish brown, 0.4–1 mm. long, 0.2–0.5 mm. broad; blade narrower, acuminate, 0.5–1 mm. long, 0.1–0.2 mm. broad. Permanent branches often developed. Deciduous branchlets simple or often producing an iterative axis from the first node, (2–) 4–10 cm. long, 0.2–0.4 (–0.7) mm. thick, stramineous or greenish and usually purplish-tinged, smooth or scabridulous, terete or angled, with (5–) 10–30 nodes; first internode mostly 5–15 mm. long, median internodes c. 2–6 mm. long. Leaves: stipules triangular to lanceolate, 0.3–1 mm. long, 0.15–0.5 mm. broad, acuminate, truncate at the base, entire, purplish-flecked with a whitish scarious margin. Petioles 0.3–0.7 mm. long. Leaf-blades membranous, elliptic to obovate or sometimes suborbicular, mostly 5–15 mm. long and 2–10 mm. broad, acute or obtuse and apiculate at the tip, acute or obtuse and sometimes inequilateral at the base, sometimes somewhat falcate in outline; above light or dark green, often purplish-stained, smooth or sometimes scabridulous, the nerves inconspicuous; beneath pallid, often purplish-speckled, smooth or scabridulous, the midrib raised and prominent, the laterals (c. 4–6 on a side) straight, anastomosing intramarginally, obscure or purplish and conspicuous; margins smooth, plane.

Deciduous branchlets mostly floriferous; flowers solitary, the male either proximal or distal to the female (male flowers fugacious and branchlets sometimes thus appearing entirely female).

Male flower: pedicel c. 1–5 (–6) mm. long. Calyx-lobes 5 (rarely 6), equal or unequal, ovate to elliptic or sometimes obovate, 0.5–1.5 (–1.7) mm. long, 0.4–1 (–1.4) mm. broad, obtuse or acute, entire, usually greenish white densely flecked or stained with purple, the purplish midrib unbranched. Disk-segments 5 (6), cuneate, subentire, small and inconspicuous, scarcely if at all protruding from beneath the synandrium. Synandrium subsessile, c. 0.5–0.8 (–0.9) mm. across, c. 0.15 mm. high; connective 0.25–0.5 (–0.75) mm. in diameter, concave or plane, often with a central rounded knob c. 0.1 mm. across; pollen grains c. 17.5–21 μ in diameter.

Female flower: pedicel 1.5–4 (–5) mm. long, greenish or more often purplish, smooth or scabridulous, terete, gradually broadening upwards. Calyx-lobes 6 (rarely 5), ovate (in flower) becoming elliptic to obovate (in fruit), 0.9–2 mm. long, 0.4–1.3 mm. broad, obtuse or rounded to acute, more or less purplish-stained, the midrib unbranched. Disk irregularly cut into (5–) 7–9 cuneate, thin, purple-flecked segments, these sometimes more or less connate. Ovary smooth; styles free, ascending or horizontally spreading, rather thick and fleshy, purple-flecked, 0.2–0.4 mm. long, 1/3- to 2/3-parted, the branches divergent, the narrowed obtuse tips recurved.

Capsule obtusely trigonous, smooth, 2–26 mm. in diameter, stramineous, the nerves not apparent. Seeds when mature 0.9–1.4 mm. long, 0.7–1

(-1.2) mm. radially and tangentially, dark greyish brown, with fine slightly raised closely arranged dark points in longitudinal rows; hilum triangular, brownish, c. 0.2 mm. across.

As pointed out earlier (Contr. Gray Herb. 176: 48-50. 1955), this widespread and variable species must take the name *Phyllanthus lindenianus*, since the earlier *P. cyclanthera* Baill. is a *nomen confusum* incapable of typification. At the time of that nomenclatural discussion, three distinct species were recognized within the *P. lindenianus* complex, but since then further study (including the examination of additional material) has led to a reevaluation. It has become apparent that the relative amount of scabridulousness on various organs is not as valuable a diagnostic character as had been thought. A comparison of MAP VI, which shows the specimens of *P. lindenianus* distributed by variety, with MAP V, in which the same specimens are scored as to scabridulousness and habit, shows that the variation pattern in these characters is not perfectly correlated with the recognized subspecific taxa. The fluctuation of characters appears so extensive, in fact, that one might think the recognition of varieties within this species is an artificial procedure which cuts across natural, random patterns of variation. However, although the available specimens constitute an admittedly incomplete sampling of the populations, the present classification seems justified for at least two reasons. In the first place, with the exception of var. *lindenianus* and var. *inaequifolius*, the varieties are allopatric, with well-defined ranges. Furthermore, the various populations include representatives with such divergent features — as the suffruticose habit of var. *inaequifolius* or the seed size of var. *leonardorum* — that it would be definitely misleading to obscure this geographically localized diversity by recognizing no subspecific entities.

A previously neglected feature which appears to be of some importance is the spatial relationship of the sexes. In var. *lindenianus* the male flowers are at the proximal nodes of the branchlet and the female flowers are distal, while in the other varieties this is reversed, the female being proximal to the male. This inflorescence character has been used with some misgiving, since it is very difficult to determine the disposition of the sexes in many specimens and since further study may perhaps demonstrate more variation in this respect than there now appears to be. A careful inspection of the relative positions of the male and female flowers is commended to those who may have occasion to encounter this species in the field.

KEY TO THE VARIETIES

1. Seeds 0.9-1 mm. long; female calyx-lobes acute; slender annual with smooth stems but scabridulous female pedicel; iterative axes typically lacking; northern Haiti var. *leonardorum* (12c)
1. Seeds 1.2-1.4 mm. long; female calyx-lobes obtuse

or rounded; at least some branchlets on every plant with iterative axes.

2. Male flowers proximal and female distal on the main or iterative axis of branchlet; stem, and usually the female pedicel, scabridulous; stems usually unbranched at base; Cuba, southern Hispaniola var. *lindenianus* (12a)
2. Male flowers distal and female proximal; stem, and usually the female pedicel, smooth.
3. Perennial, with several stems clustered at the base; leaves of upper branchlets often conspicuously smaller than those below; southern Hispaniola var. *inaequifolius* (12d)
3. Annual, with a single unbranched main stem; leaves all approximately the same size; central Hispaniola var. *jimenezii* (12b)

12a. *Phyllanthus lindenianus* var. *lindenianus*

(PLATE XVIII, fig. 4).

Phyllanthus lindenianus Baill. *Adansonia* 2: 13. 1861.

Phyllanthus gracilissimus Baill. op. cit. 14.

Phyllanthus cyclanthera β *scabrellus* Muell. Arg. *Linnaea* 32: 44. 1863.

Phyllanthus cyclanthera γ *gracillimus* Muell. Arg. *ibid.*

Phyllanthus cyclanthera α *lindenianus* (Baill.) Muell. Arg. in DC. *Prodr.* 15(2): 408. 1866.

Annual, or possibly sometimes perennial, but with a single main stem unbranched at base; stem 1–4 dm. high, 1.5–3 mm. thick, stramineous to purplish and rather sparsely scabridulous or almost whitish due to densely compacted papillae. Cataphylls: stipules 0.7–1 mm. long, 0.3–0.5 mm. broad; blade 0.5–1 mm. long. Deciduous branchlets usually with an iterative axis from the first node; main axis (4–) 5–8 (–10) cm. long, greenish or purplish, sparsely to densely papillate or scabridulous, with mostly 10–20 nodes. Leaves: stipules 0.5–0.8 (–1) mm. long, 0.2–0.5 mm. broad; blades mostly 5–15 mm. long, 2–10 mm. broad, elliptic to obovate, above smooth or conspicuously scabridulous, beneath nearly smooth to conspicuously scabridulous. Branchlets typically with proximal male flowers and 1–6 distal female flowers on both main and iterative axes, or sometimes remaining entirely male. Male flower: pedicel 1.5–3.5 (–6) mm. long; calyx-lobes elliptic to obovate or less commonly ovate, 0.8–1.5 (–1.7) mm. long, (0.6–) 0.7–1 (–1.4) mm. broad; synandrium 0.5–0.8 (–0.9) mm. across; connective purple-flecked, 0.3–0.6 (–0.75) mm. in diameter. Female flower: pedicel 1.7–3.5 (–5) mm. long, purplish at least above, scabridulous (rarely almost smooth); calyx-lobes elliptic to obovate, mostly 1.5–2 mm. long, (0.7–) 0.9–1.3 mm. broad, obtuse or rounded at the tip; styles 0.35–0.4 mm. long. Capsule c. 2.5–2.6 mm. in diameter; seeds 1.2–1.4 mm. long, c. 1 mm. radially and tangentially.

TYPE: Cuba, Monte Libano, *Linden* 1827 ex p.

DISTRIBUTION: Cuba and western Hispaniola (MAP VI).

CUBA. PINAR DEL RIO: Sierra de las Animas, 15 Mar. 1920, *Ekman* 10508 (S). ORIENTE: Monte Libano, May 1844, *Linden* 1827 ex p. (P, HOLOTYPE; G, ISOTYPE); Loma de Jagüey, alt. 600 m., among rocks, Mar. 1889, *Eggers* 4928 (P, SV); Monte Verde, on rocks in dense woods, 7 July 1859, *Wright* 1935 (G, GH, GOET, MO, W).

HAITI. SUD: Massif de la Hotte, central group, St.-Louis du Sud, Bonnet-Carre, limestone, c. 1150 m., 2 Nov. 1927, *Ekman* H9229 (S).

DOMINICAN REPUBLIC. BARAHONA: Nochebuena Berge, alt. 1200 m., Sept. 1910, *Fuertes* 345 (C, F, G, GH, MO, P, S, US); Las Filipinas, 1200 m. alt., Apr. 1912, *Fuertes* 1470 (C, F, G, GH, P, S, US).

The somewhat aberrant form described as *P. gracilissimus* is represented by the following two specimens:

CUBA. ORIENTE: Monte Liban, *Linden* 1827 ex p. (P, HOLOTYPE of *P. gracilissimus*); "entree des cavernes du Mt. Liban", *Linden* 1827 ex p. (BR, ISOTYPE).

Baillon published *P. lindenianus* and *P. gracilissimus* at the same time, basing the two species on different plants from the same collection. Although Baillon considered the two species as very distinct, one must agree with Mueller (DC. Prodr. 15[2]: 408. 1866) that neither Baillon's descriptions nor the specimens furnish any convincing distinguishing characters. The type specimen of *P. gracilissimus* is indeed peculiar in several points: the flowers are small, the sharply acute male calyx-lobes are merely purple-striped down the center instead of being diffusely purplish-tinged, the disk of the female flower is 3-lobed, and the plant has a slenderer more fragile aspect which well justifies Baillon's specific epithet. In gross appearance the plant bears a striking resemblance to var. *leonardorum*, but it does not agree in technical characters; on the other hand, in its habit and male flowers the type specimen of *P. gracilissimus* is almost exactly intermediate between var. *lindenianus* and *P. tenuicaulis*. Serious consideration must therefore be given to the possibility that it represents a hybrid between *P. lindenianus* and *P. tenuicaulis*, especially since intermediates between *P. lindenianus* var. *leonardorum* and *P. tenuicaulis* have been collected in northern Haiti. However, thus far *P. tenuicaulis* has not been found in the Monte Libano region in Oriente, the two known localities both being in the Sierra Maestra. The exact status of the plant referred to *P. gracilissimus* by Baillon must therefore remain in doubt.

Even if *P. gracilissimus* is excluded from consideration, var. *lindenianus* remains a polymorphic entity which is rather difficult to delimit. The Cuban plants, which have a tendency to greater scabridulousness (particularly on the leaves), evidently belong together; but some of the specimens from Hispaniola, where the range of the variety overlaps that of

var. *inaequifolius*, are somewhat discordant. *Ekman H9229* from the Massif de la Hotte appears to be perennial like var. *inaequifolius* and has unusually large synandria up to 0.9 mm. in diameter, but because of its uniform leaves and scabridulous stems must be classified with the present variety.

12b. *Phyllanthus lindenianus* var. *jimenezii*, var. nov.¹⁶

Herb with a single main stem, apparently annual, decumbent at the base but erect above, up to 8 dm. high (ex coll.); stems smooth, purplish-tinged. Cataphylls: stipules c. 0.6–0.7 mm. long, blade about as long. Deciduous branchlets either with or without an iterative axis from the first node; main axis 6–10 cm. long, purplish, smooth, with c. 15–30 leaves. Leaves: stipules 0.8–1 mm. long, c. 0.3–0.4 mm. broad; blades broadly elliptic, mostly 6–10 mm. long, 3–5.5 mm. broad, obtuse or rounded and apiculate at the tip, smooth on both sides. Branchlets with proximal female and distal male flowers, whether or not main axis is branched. Male flower: pedicel c. 1.5 mm. long; calyx-lobes ovate to elliptic, 0.8–0.9 mm. long, 0.6–0.75 mm. broad, obtuse or subacute; synandrium c. 0.75 mm. across, connective c. 0.5 mm. in diameter. Female flower: pedicel becoming 4–5 mm. long, purplish, smooth or obscurely roughened; calyx-lobes oblong-ovate to elliptic, 1.2–1.5 mm. long, 0.7–0.9 mm. broad, obtuse or rounded at the tip; styles c. 0.35 mm. long. Mature capsule not seen entire; seeds c. 1.4 mm. long, 1.2 mm. radially and tangentially.

DOMINICAN REPUBLIC: Constanza, El Salto de Constanza, alt. 1200 m., 15 July 1955, *Jiménez 2972* (US 2114149, HOLOTYPE).

DISTRIBUTION: known only from the type (MAP VI).

This variety is still poorly known, and the description may have to be modified when additional material becomes available. In general aspect var. *jimenezii* approaches more closely to var. *lindenianus* than to either of the other varieties, but it differs sharply in its completely smooth parts and apparently in its inflorescence. The fact that the *Jiménez* specimen represents a geographically isolated population which cannot be accommodated within any of the three previously known varieties makes it seem advisable to designate it as the type of a new variety. However, since var. *jimenezii* combines some of the features of var. *inaequifolius* and var. *lindenianus*, its discovery has not only been influential in the decision not to recognize those two taxa as independent species, but has also raised the possibility that the present four varieties of *P. lindenianus* may be merely arbitrary concepts which mask a complex and random pattern of variation. Although this seems unlikely, only future collecting can settle the question.

¹⁶ *Phyllanthus lindenianus* var. *jimenezii*, var. nov.

Verisimiliter annuus, omnino laevis; foliis membranaceis, ellipticis, plusminusve inter se aequalibus, 6–10 mm. longis; lobis calycis florum masculorum c. 0.8–0.9 mm. longis, florum femineorum c. 1.2–1.5 mm. longis; seminibus c. 1.4 mm. longis.

12c. *Phyllanthus lindenianus* var. *leonardorum* (Webster), stat. nov.

Phyllanthus leonardorum Webster, Contr. Gray Herb. 176: 50. 1955.

Slender erect annual; stem unbranched except above, 0.5–2.5 dm. high, 0.4–1.3 mm. thick, usually pale stramineous-whitish or greenish below, purplish and more or less pruinose above, smooth or very obscurely and remotely scabridulous. Cataphylls: stipules 0.4–0.8 mm. long, 0.15–0.25 mm. broad; blade 0.5–0.7 mm. long, 0.1–0.2 mm. broad. Deciduous branchlets with a female flower at the first node or less commonly producing an iterative axis there, (2–) 4–6 (–7) cm. long, purplish, smooth, with 5–25 leaves. Leaves: stipules 0.3–0.6 mm. long, 0.2–0.3 mm. broad, blades obovate or elliptic, (2–) 4–9 mm. long, (1.5–) 2–5 mm. broad, smooth on both sides. Branchlets very often with a female flower at the first node, the succeeding two nodes typically bearing male flowers; this arrangement repeated with more or less regularity the entire length. Male flower: pedicel 0.75–2 mm. long; calyx-lobes usually ovate-triangular and sharply acute (sometimes obovate and obtuse), 0.5–0.8 mm. long, 0.4–0.8 mm. broad; synandrium 0.45–0.5 mm. across, connective 0.25–0.3 mm. in diameter, yellowish white. Female flower: pedicel 1.6–3.5 mm. long, greenish or purplish, scabridulous; calyx-lobes ovate in flower, tending to become obovate in fruit, 1–1.4 mm. long, 0.3–0.6 mm. broad, narrowed to an acute tip; styles 0.2–0.35 mm. long. Capsule c. 2–2.2 mm. in diameter; seeds c. 0.9–1.1 mm. long, 0.7–0.9 mm. broad.

TYPE: Haiti, *E. C. & G. M. Leonard* 12624.

DISTRIBUTION: dry calcareous areas, central and northern Haiti (MAP VI).

HAITI. NORD-OUEST: Presqu'île du Nord-Ouest, Port-de-Paix, cultivated place in Prosopis thickets south of Saline-Michel, 12 Apr. 1925, *Ekman* H3756 (S); west of Saline-Michel, 15 Mar. 1928, *Ekman* H9702 (S); vicinity of Jean Rabel, Môle Road, 27 Jan. to 9 Feb. 1929, *E. C. & G. M. Leonard* 12624 (GH, HOLOTYPE; MICH, MO, NY, US, ISOTYPES). ARTIBONITE: Massif des Matheux, l'Archaie, Trou-Forban, in Bayahonde thickets, 10 Oct. 1926, *Ekman* H7092 (S, US).

Variety *leonardorum* is perhaps the most xerophytic population of *P. lindenianus*; and it is so well characterized by its depauperate habit, small fruit and seeds, and usually unramified branchlets, that it was originally described as a distinct species. However, further analysis of the variation within the *P. lindenianus* complex has led to the conclusion that it is preferable to regard *P. leonardorum* as a geographically and ecologically isolated variety of the inclusive species *P. lindenianus*.

In aspect var. *leonardorum* strongly resembles *P. tenuicaulis*, which also occurs in northern Haiti; the latter, however, may be easily distinguished by its lack of purplish coloration. It is difficult to decide whether the resemblance between the two taxa is due to close affinity (var. *leonardorum* possibly representing the group through which *P. lindenianus* evolved from *P. tenuicaulis*), or to hybridization between them, or to both of these

factors. An intermediate specimen possibly of hybrid origin (*Leonard & Leonard 12630*) has already been discussed under *P. tenuicaulis*.

The Ekman collection from the Massif de Matheux differs from the other collections of var. *leonardorum* in aspect, blunter lobes of the male calyx, and shorter fruiting pedicels. However, until other collections are available from the area it is impossible to tell whether it represents anything more than a local variant.

12d. *Phyllanthus lindenianus* var. *inaequifolius* (Webster), stat. nov. (PLATE XVII, figs. A-C; PLATE XVIII, fig. B).

Phyllanthus inaequifolius Webster, Contr. Gray Herb. 176: 48. 1955.

Suffrutescent perennial 3-7 dm. high with few to several main stems diverging from the base; stems subsimple above, smooth, brownish below, above olivaceous and more or less purplish-tinged. Cataphylls: stipules 0.7-1 mm. long, mostly 0.3-0.4 mm. broad; blade 0.7-1 mm. long, c. 0.15-0.2 mm. broad, commonly adnate to the stipules in the lower half. Deciduous branchlets, at least those above, usually with an iterative axis from the first node; main axis 5-10 cm. long, green or purplish, smooth, with mostly 15-30 leaves; leaves of lower branchlets usually conspicuously larger than those of the upper branchlets, the transition more or less abrupt, or sometimes leaves not noticeably unequal. Leaves: stipules 0.7-1 mm. long, c. 0.3 mm. broad; blades membranous to chartaceous, elliptic to obovate, usually obtuse and apiculate at the tip, smooth on both sides, the smaller c. 2-5 mm. long and 1-2.5 mm. broad, the larger c. 5-15 mm. long and 3-8 mm. broad. Branchlets ordinarily not producing female flowers on the main axis (unless it is unramified), but often with distal male flowers; iterative axis with (1-) 3 proximal female flowers, succeeded distally by several males. Male flower: pedicel 1.7-3.7 mm. long; calyx-lobes mostly ovate, 0.7-1 (-1.2) mm. long, 0.5-0.9 mm. broad, acute or subacute; synandrium 0.5-0.75 mm. across, connective 0.3-0.5 mm. in diameter. Female flower: pedicel 1.7-4 mm. long, purplish, smooth; calyx-lobes ovate to obovate, 0.9-1.3 mm. long, 0.6-0.9 mm. broad, obtuse at the tip; styles 0.35-0.4 mm. long. Capsule c. 2.2-2.3 mm. in diameter; seeds 1.2-1.4 mm. long, 1-1.1 mm. radially and tangentially.

TYPE: Haiti, *Ekman H1344*.

DISTRIBUTION: limestone areas, southern Haiti (MAP VI).

HAITI. SUD: slopes of limestone hills near Randelle, at roadside, not far from Port-à-Piment, 12 Aug. 1917, *Ekman H674* (S). OUEST: Massif de la Selle, Morne Brouet, on dry ridges, alt. 1700 m., 6 Aug. 1924, *Ekman H1344* (S, HOLOTYPE; US, ISOTYPE); Mornes des Commissaires, in open pine forest, alt. 1600 m., 17 Oct. 1941, *Holdridge 859* (MICH, NY, US); vicinity of Mission, Fonds Varettes, alt. 1000 m. and above, 17 Apr. to 4 May 1920, *Leonard 3985* (NY, US); vicinity of Furcy, Morne de Wegan, cliff, alt. c.

1300 m., *Leonard 4600* (US); Mornes des Commissaires, on mossy limestone boulders, alt. 5560 ft., 17 Sept. 1955, *Proctor 10865* (A).

The plant of the type collection, *Ekman H1344*, has such a distinctive aspect due to its perennial habit with the leaves abruptly smaller above that it was originally described as a species distinct from *P. lindenianus*. However, the examination of additional material has shown that only the two Ekman collections have a marked difference in leaf size; furthermore, the population typified by *Ekman H1344* agrees in essential details of leaf, flower, and seed with typical *P. lindenianus*. As MAP V demonstrates, the scabridulous character of stem, female pedicel, and calyx is too fluctuating to serve for the delimitation of distinct species. The difference in disposition of the sexes may prove to hold even when more material becomes available, but even so it does not appear to outweigh the many apparent similarities. Consequently, the preferable course is to recognize this population of southern Haiti as a variety of the widespread *P. lindenianus*.

A difficulty raised by the adoption of the present concept is that at least one collection of var. *lindenianus* (*Ekman H9229*) lies within the known range of var. *inaequifolius*. If further collecting should make it apparent that the two entities occur sympatrically over much of southern Haiti without intergradation, the possibility of specific status for var. *inaequifolius* might have to be re-examined. However, *Ekman H9229* is itself such an aberrant representative of var. *lindenianus* that it can hardly be taken as evidence for the sympatric distribution of the two varieties.

13. *Phyllanthus abditus* Webster, Contr. Gray Herb. 176: 50. 1955.
(PLATE XVII, figs. D-E; PLATE XVIII, fig. C).

Suffruticose perennial c. 4 dm. high with several erect stems clustered on a caudex; stems terete, smooth, greenish, somewhat zigzag above, c. 1.5 mm. thick; internodes c. 10–25 mm. long. Leaves of main stems reduced to cataphylls: stipules lanceolate, c. 1 mm. long, 0.3–0.4 mm. broad, acuminate, purplish-flecked, entire; blade narrower, more or less adnate to the stipules in the lower half. Deciduous branchlets simple below but upper ones producing an iterative axis from the first node; main axis 6–9 cm. long, 0.2–0.4 mm. thick, green, smooth, terete or somewhat angled below, with c. 25–35 leaves; first internode 5–7 mm. long, median internodes 2–6 mm. long. Leaves: stipules lanceolate, 0.8–0.9 mm. long, 0.2–0.3 mm. broad, acuminate, purplish. Petioles 0.5–0.75 mm. long. Leaf-blades membranous, elliptic or obovate, c. 5–12 mm. long, 3–6 mm. broad, broadly obtuse or rounded and apiculate at the tip, cuneate or obtuse at the base, smooth on both sides; above bright green, the nerves (except the midrib) obscure; beneath pallid, the laterals forming a delicate reticulum; margins smooth, unthickened.

Deciduous branchlets never with a female flower at the first node (an iterative axis produced instead), the female flowers 1 (or sometimes 2?)

per branchlet, produced on the proximal part of either the main or iterative axis, the several male flowers distal.

Male flower: pedicel 1.4–1.8 mm. long. Calyx 1.7–1.8 mm. long; calyx-lobes 5, purple-flecked, 1-nerved, fused in the lower third into a turbinate cup c. 0.6–0.7 mm. high which is constricted at the juncture with the lobes; free portion of lobes broadly ovate or suborbicular, 1–1.2 mm. long, 0.8–1.2 mm. broad, obtuse or rounded, purple-flecked, the midrib unbranched, entire with an extremely narrow thickened margin. Disk-segments 5, suborbicular, fleshy, rather thick, whitish, concealed in the



MAP VII. Distribution of *Phyllanthus abditus* Webster (starred circle) and *Phyllanthus berterioanus* Muell. Arg. (solid circles).

calycine cup at the base of the synandrial column. Synandrium on a column c. 0.7 mm. high, c. 0.15–0.2 mm. thick, tapering slightly upwards, lightly purplish-tinged; synandrium circular or elliptic in outline, c. 0.7–0.8 mm. across; connective c. 0.45–0.5 mm. in diameter, purplish-flecked, with a conspicuous central knob; pollen grains c. 17–21 μ in diameter.

Female flower: pedicel 3.3–3.7 mm. long, purplish, smooth, tapering upwards from the slender lower half. Calyx-lobes 6, separate essentially to the base, obovate, 1.4–1.6 mm. long, 0.75–0.9 mm. broad, rounded at the tip, entire, purplish-flecked or nearly immaculate, midrib unbranched. Disk divided as in *P. lindenianus* into c. 7 or 8 thin, cuneate segments up to 0.2 mm. long. Ovary smooth; styles united at the base into a short but definite column 0.15–0.2 mm. high, steeply and divergently ascending, 0.5–0.6 mm. long, 2/5-parted to bifid, slender, the branches diverging, the acute tips recurved.

Capsules not seen entire; valves olivaceous, nerveless. Seeds c. 1.25 mm. long, 1 mm. radially and tangentially, dark brown, with longitudinal rows of dark raised points; hilum triangular, c. 0.25 mm. across.

TYPE: Haiti, Dépt. Sud, Massif de la Hotte, western group, Camp Perrin, northern slope of Morne Vandervelde, on rocks at Source Mare Blanche, c. 700 m., 30 Nov. 1925, *Ekman H5197* (S, HOLOTYPE; associated on the sheet with *Lygodium volubile* Sw.).

DISTRIBUTION: known only from the type collection (MAP VII).

This restrictedly endemic species resembles *P. lindenianus* var. *inaequifolius* in a number of ways, and perhaps is most closely related to it. Vegetatively the present species could hardly be distinguished from forms of *P. lindenianus*, but the floral characters are so distinctive that *Ekman H5917* surely must represent a distinct species rather than a mere aberrant state of *P. lindenianus*. However, there is little doubt that *P. abditus* is closely related to that species and does not stand as isolated in the section as does *P. berterioanus*.

14. *Phyllanthus berterioanus* Muell. Arg. *Linnaea* 32: 44. 1863; DC. *Prodr.* 15(2): 408. 1866.

(PLATE XVII, *figs. F-G*; PLATE XVIII, *fig. D*).

Diasperus berterioanus (Muell. Arg.) O. Ktze. *Rev. Gen.* 2: 598. 1891.

Phyllanthus anisophyllus Urb. *Repert. Sp. Nov.* 18: 364. 1922.

Perennial herb c. 3–8 dm. high, with one to several terete erect stems from a woody base; all parts completely smooth and glabrous. Lowermost c. 15–20 nodes on main stems bearing large leaves and no branchlets, the subsequent leaves (subtending branchlets) on the main stem and those on the branchlets more or less abruptly reduced in size. Leaves of main axis, though reduced above, mostly not completely scale-like: stipules lanceolate, c. (0.7–) 1.2–2 mm. long, 0.4–0.8 mm. broad, acuminate, entire, olivaceous or brownish, scariosus. Petioles of lower leaves up to 2 mm. long, those of uppermost leaves less than 1 mm. long. Larger blades (those not subtending branchlets) oblanceolate, obcuneate, oblong, or elliptic, usually coriaceous (more rarely membranaceous), 15–75 mm. long. Deciduous branchlets invariably unbranched, mostly 5–10 cm. long, sometimes (particularly those from lower nodes) up to 20 cm. long or at the apex reduced to c. 2.5 cm. long, 0.3–0.6 (–0.9) mm. thick, olivaceous, subterete, with 10–25 (–40) leaves; first internode mostly 5–12 mm. long (up to 20 mm. on lower branchlets), median internodes 2–8 mm. long. Leaves: stipules lanceolate, 0.7–1.2 (–1.5) mm. long, 0.25–0.4 (–0.5) mm. broad, acuminate, olivaceous with yellowish entire margins, the tip more or less scariosus. Petioles of smaller leaves c. 0.4–1 mm. long, of larger leaves 1–1.5 (–2) mm. long. Leaf-blades coriaceous to membranous, mostly elliptic or oblong, sometimes slightly falcate, 3–15 (–20) mm. long, 2–8 (–11) mm. broad (those of the upper branchlets often strikingly smaller than those of the lower), obtuse to acute with a conspicuous scariosus-indurate apiculum, obtuse at the base; above olivaceous, sublucid, the midrib plane or very slightly raised, the laterals usually obscure; beneath yellowish green or rarely whitened, the midrib conspicuously raised, the laterals (c. 4 or 5 on a side) and the fine reticulum of tertiaries subprominent to obscure; margins plane or reflexed, not revolute.

Monoecious; female flowers 1–3 (–4) at the distal nodes of the branchlet, male flowers at the proximal nodes (first node sometimes barren);

both sexes borne on the same or sometimes perhaps on different branchlets.

Male flower: pedicel 4–7 mm. long. Calyx-lobes 6, biseriate, subequal, ovate or triangular, (0.9–) 1–1.4 mm. long, (0.8–) 1–1.7 mm. broad, obtuse or acute, entire, yellowish or greenish white and often purplish-tinged at base, midrib pinnately branched. Disk-segments 6, obovate to squarish in outline, distal portion fleshy, purplish, petaloid, 0.4–0.65 mm. long, 0.5–0.9 mm. broad. Stamens 3; synandrium subsessile, (0.5–) 0.7–0.9 (–1) mm. across, round or trigonous in outline; connective more or less plane, purplish, (0.4–) 0.5–0.8 mm. in diameter; pollen grains c. 26–27 μ in diameter.

Female flower: pedicel (5–) 6–10 (–12) mm. long, olivaceous or stramineous, terete below, becoming angled and gradually thickened above. Calyx-lobes 6, biseriate, subequal, ovate to suborbicular, (1.5–) 1.7–2.3 mm. long and about as broad, blunt to subacute at the tip, entire, olivaceous, midrib pinnately branched; lobes spreading or reflexed in fruit. Disk-segments 6, obcuneate or obovate, purplish and petaloid as in the male, persistent with the fruiting calyx. Ovary smooth, depressed at anthesis, the horizontal styles nearly touching the disk; styles free, 0.4–0.5 mm. long, bifid, the branches divergent, the slender tips recurved.

Capsule oblate, rounded-trigonous, c. 3.7–4.2 mm. in diameter, smooth, stramineous, the veins completely obscure. Columella c. 1.3–1.5 mm. long. Seeds trigonous, (1.8–) 1.9–2.3 mm. long, (1.4–) 1.5–1.8 (–2) mm. radially, (1.4–) 1.5–2 mm. tangentially, dark brown to almost black, colliculose with slightly raised transversely elongated dots; hilum roundish, c. 0.3–0.4 mm. in diameter.

TYPE: "St. Domingue," *Bertero* (G, HOLOTYPE; P, ISOTYPE). The exact locality of *Bertero*'s collection is not known.

DISTRIBUTION: calcareous areas, northern Hispaniola (MAP VII).

HAITI. NORD-OUEST: vicinity of Jean Rabel, rocky slope of mountain south of town, 4 Mar. 1929, *E. C. & G. M. Leonard* 13709 (US); Massif du Nord, Port-de-Paix, Morne Fourris, deep limestone cliffs, alt. c. 400 m., 30 Apr. 1925, *Ekman* H3960 (S, US). ARTIBONITE: vicinity of St. Michel de l'Atalaye, alt. c. 350 m., cultivated slope, Habitation Baille, 26 Nov. 1925, *Leonard* 7477 (US); vicinity of Marmelade, alt. c. 800 m., dry bank, road to St. Michel, 21 Dec. 1925, *Leonard* 8421 (US); Camp No. 4, Marmelade, pine-land, alt. c. 2950–3050 ft., 1 & 2 Aug. 1905, *Nash & Taylor* 1265, 1276 (NY); Ennery, in thickets on soft limestone, c. 400 m., 14 Nov. 1924, *Ekman* H2449 (S, US); Massif du Nord, Hinche, Morne Pedregal, Oligocene limestone, 600 m., 13 May 1926, *Ekman* H6093 (S); vicinity of Ennery, alt. 325–900 m., dry bank, Puilboreau road, 13 Jan. 1926, *Leonard* 8826 (NY, US); vicinity of Ennery, alt. 325–900 m., on rocks, 19–21 Jan. 1926, *Leonard* 8989, 9063 (US).

DOMINICAN REPUBLIC. MONTE CRISTI: Cordillera Central, Monción, at La Harquetta, limestone, c. 400 m., 29 May 1929, *Ekman* H12661 (S). SANTIAGO: Cordillera Central, Santiago, road to Jánico, c. 350 m., Miocene limestone, hillsides, 16 Nov. 1930, *Ekman* H16159 (S); Cordillera Septentrional, Santiago, Cuesta de Piedras, rocky slope, c. 200 m., 23 Nov. 1930, *Ekman* H16231

(S, US); El Buzo, 900 m. alt., 14 Jan. 1945, *Jiménez 301* (A, US). ESPAILLAT: near Salcedo, 31 Oct. 1954, *Jiménez 2763* (US). SAMANA: Samaná Peninsula, vicinity of Sanchez, sea level to 300 m. alt., base of limestone cliff, 29 Nov. to 12 Dec. 1920, *Abbott 165, 166* (US); Samaná, Boca de Río San Juan, steep cliffs, 17 May 1930, *Ekman H14998* (S).

Phyllanthus berterioanus is probably the most abundant species in sect. *Cyclanthera*, although in overall area of distribution it must yield first place to *P. lindenianus*. It appears to be common everywhere along the chain of mountains which roughly parallels the northern coast of Hispaniola. Morphologically *P. berterioanus* is the most sharply defined representative of sect. *Cyclanthera*; although it is somewhat similar in aspect to *P. lindenianus* var. *inaequifolius*, it can be only distantly related to that plant. The striking petaloid disk-segments, branching calycine midrib, and large fruit and seeds show that *P. berterioanus* occupies a very isolated position within sect. *Cyclanthera*. The unreduced and often coriaceous leaves on the main stem and the lack of iterative axes on the branchlets make it possible to identify this species from vegetative material alone.

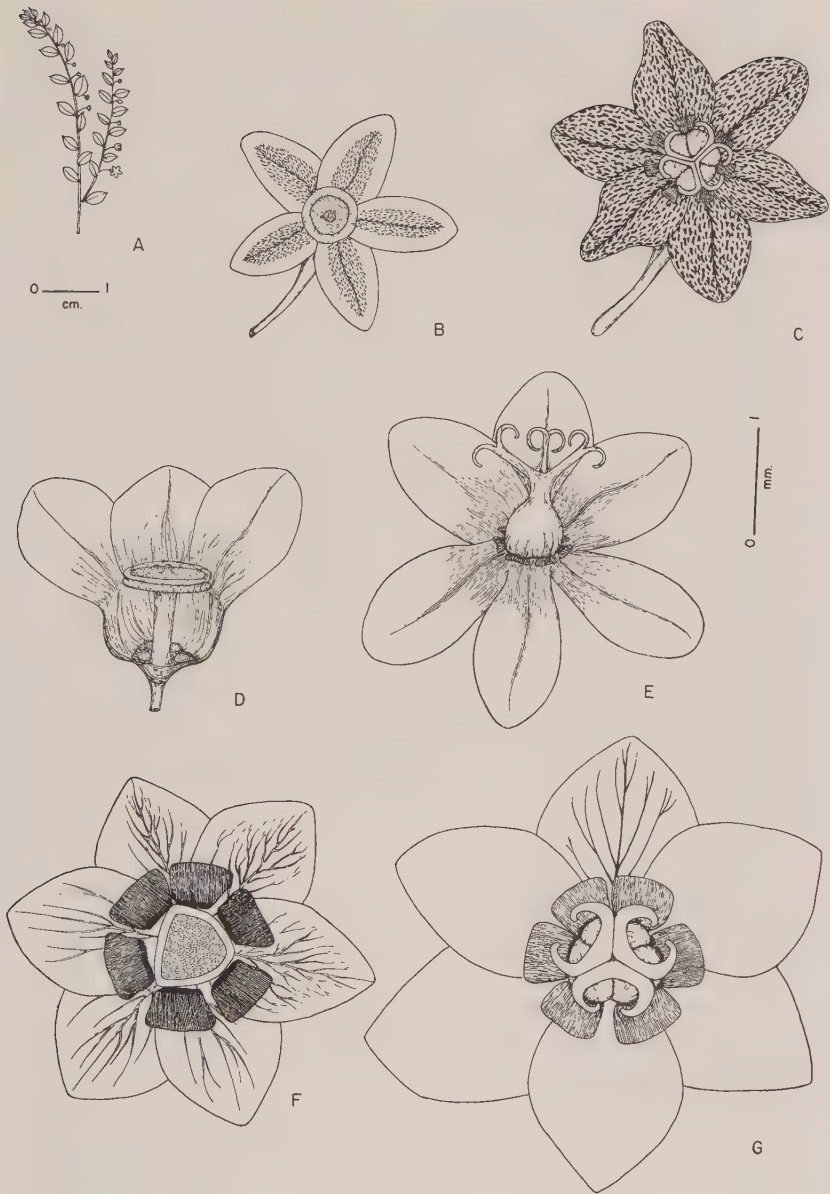
As might be expected for such a wide-ranging species, there is considerable intraspecific variation in *P. berterioanus*, particularly in the size and texture of the leaves; but the variation patterns are so indefinite that it does not seem desirable to create any subspecific entities. Urban's *P. anisophyllus*, said to differ in its leaf form and disk-segments, was based on *Buch 1062* from Plaisance, Haiti, and *Abbott 165* from the Samaná Peninsula. The *Buch* collection has unfortunately not been examined, and Urban's specimen was presumably lost in the destruction of the Berlin Herbarium. However, the *Abbott* collection, although deviating from the norm by virtue of its larger and thinner leaves, certainly does not appear to represent a distinct species. The shape of the disk-segments varies from nearly square to obovate or obcuneate, the variation depending at least partially on the amount of lateral compression. At the present time it does not appear necessary to distinguish the Samaná Peninsula population even on the varietal level.

Sect. 10. *Urinaria* Webster, Contr. Gray Herb. 176: 51. 1955.

Annual or perennial herbs with phyllanthoid branching; deciduous branchlets angled or winged, leaves hispidulous near margin, stipules conspicuously auriculate. Monoecious; female flowers solitary in the proximal

PLATE XVII. Section *Cyclanthera*.

FIGS. A-C. *Phyllanthus lindenianus* var. *inaequifolius* (Webster) Webster. A, branchlet showing iterative axis to right (*Proctor 10865* [A]); B, male flower (*Ekman H1344* [S]); C, female flower (*Ekman H1344* [S]). FIGS. D-E. *Phyllanthus abditus* Webster (*Ekman H5197* [S]). A male flower with half of calyx cut away to show calyx tube and synandrial column; B, female flower. FIGS. F-G. *Phyllanthus berterioanus* Muell. Arg. (*Ekman H1659* [S]). F, male flower; G, female flower (venation shown in only one calyx-lobe). (Figs. B-G all drawn to same scale.)



WEBSTER, WEST INDIAN PHYLLANTHUS

axils, male in cymules in the distal axils. Male flower: calyx-lobes 6; disk-segments 6, very small; stamens 3, filaments free or united; anthers erect, dehiscing vertically; pollen grains subglobose, 4-colporate, finely reticulate. Female flower: subsessile; calyx-lobes 6; disk a shallow cup; ovary conspicuously bullate, styles laterally fused at base. Capsule oblate, tuberculate; seeds trigonous, with sharp transverse ridges on back and sides, the lateral faces more or less deeply pitted.¹⁷

TYPE SPECIES: *Phyllanthus urinaria* L.

This section, included in sect. *Paraphyllanthus* by Mueller, is actually very distinctive on the basis of its characteristic stipules, spatial arrangement of the sexes, and unique seeds. It includes, in addition to the type species, four additional species described from India, Indo-China, the Philippines, and Tahiti, respectively: *P. hookeri* Muell. Arg., *P. arenarius* Beille, *P. benguetensis* C. B. Rob., and *P. societatis* Muell. Arg. Except for the problematical *P. croizatii* Steyerm. from Venezuela (which is probably only a form of *P. urinaria*), no indigenous representatives occur in the New World.

The phylogenetic relationships of sect. *Urinaria* are of considerable interest, because in many respects (particularly with regard to stipules and female flower) the species of this group resemble those of sect. *Loxopodium*. On the other hand, in branching habit the members of sect. *Urinaria* accord much more closely with sect. *Phyllanthus*. It appears at least possible that sect. *Urinaria* has evolved from sect. *Loxopodium* quite independently of sect. *Phyllanthus*, which is probably descended from some group in subg. *Kirganchia*. If this could be confirmed it would be a clear demonstration of the independent origin of phyllanthoid branching at least twice within the genus.

15. *Phyllanthus urinaria* L. Sp. Pl. 982. 1753; Muell. Arg. in DC. Prodr. 15(2): 364. 1866. (TEXT-FIG. 9).

Urinaria Indica, supina, cauliculus rubentibus Burm. Thes. Zeyl. 231. 1737.

Phyllanthus. . . floribus sessilibus, caule herbaceo proœumbente L. Fl. Zeyl. 157-158. 1747.

Phyllanthus cantoniensis Hornem. Enum. Pl. Hort. Hafn. 29. 1807.

Phyllanthus alatus Blume, Bijdr. 594. 1826.

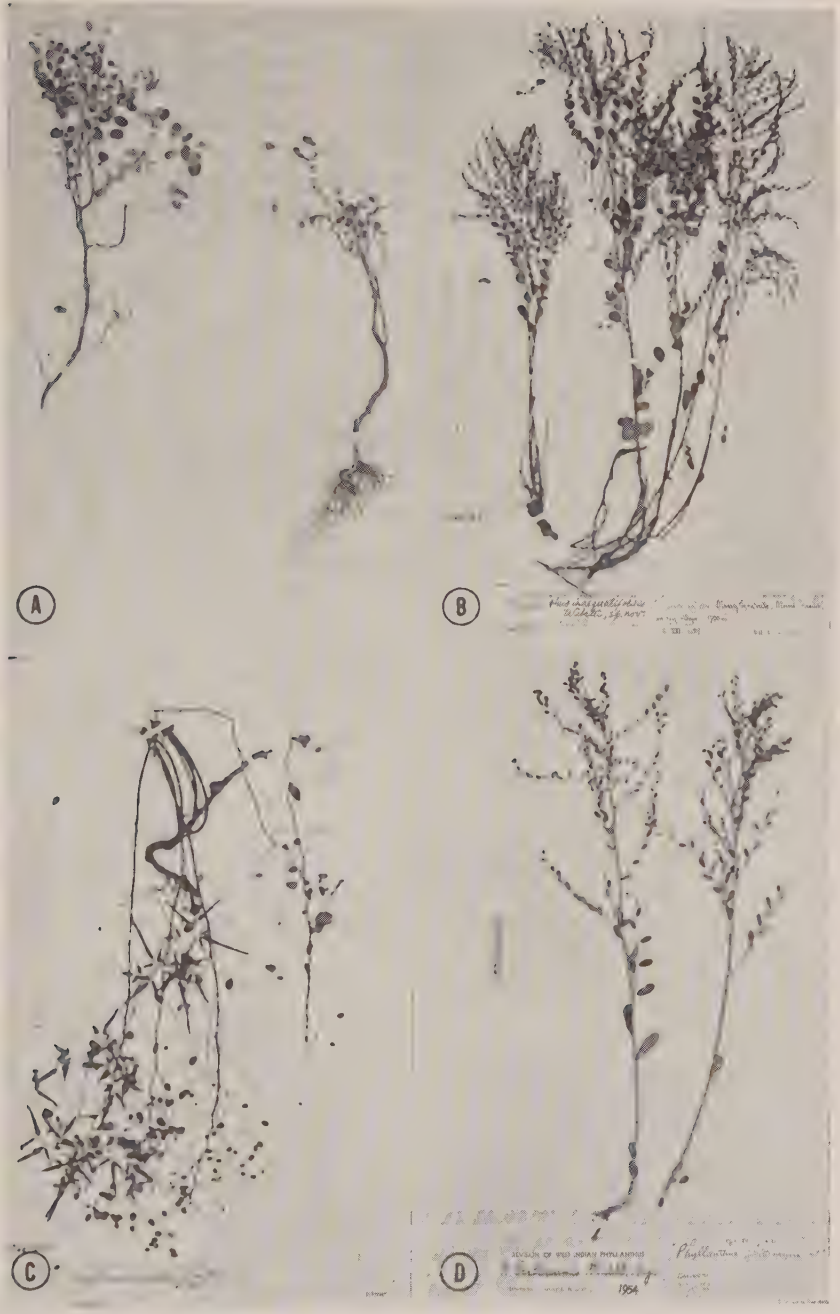
Phyllanthus lepidocarpus Sieb. & Zucc., Abh. Acad. Muench. 4(2): 143. 1843.

Phyllanthus leprocarpus Wight, Icon. Pl. Ind. Or. 5(2): pl. 1895. 1852.

PLATE XVIII. Section *Cyclanthera*.

FIG. A. Holotype specimen of *P. lindenianus* Baill. var. *lindenianus* (Linden 1827 ex p. [P]). FIG. B. Holotype specimen of *P. lindenianus* Baill. var. *i.æquifolius* (Webster) Webster (Ekman H1344 [S]). FIG. C. Holotype specimen of *Phyllanthus abditus* Webster (Ekman H5197 [S]). FIG. D. Representative specimen of *Phyllanthus berterioanus* Muell. Arg., showing fully developed leaves on main axis (Leonard 9063 [GH]).

¹⁷ See Plate XI, figs. 53 and 54.



WEBSTER, WEST INDIAN PHYLLANTHUS

Diasperus urinaria (L.) O. Ktze. Rev. Gen. 2: 601. 1891.

Phyllanthus chamaepeuce Ridl. Trans. Linn. Soc. Ser. II, 3: 345. 1893.

Erect or procumbent herb, normally annual; primary stem simple or becoming ramified, mostly 1.5–5 dm. high and 1–2.5 mm. thick, smooth and olivaceous to reddish above, nearly terete but with narrow acute ridges decurrent from the nodes. Cataphylls scarious, stramineous; stipules ovate-lanceolate, attenuate-acuminate, conspicuously auriculate at the base, the auricles denticulate or lacerate, often overlapping and stipule then appearing peltate, c. 2–3 mm. long, 0.8–1.2 mm. broad; blade ovate-lanceolate, acuminate, less conspicuously auriculate, displaced onto the base of the deciduous branchlet c. 1 mm. above the attachment of the stipules, 1.5–2.5 mm. long. Deciduous branchlets ascending, (3–) 5–10 cm. long, 0.5–0.7 (–0.9) mm. thick, olivaceous or sometimes reddish, flattened and acutely winged, the raised median area hirsutulous, with c. 20–35 leaves; first internode (3–) 5–12 (–15) mm. long, internodes between female flowers (2.5–) 3–5 (–7) mm. long, between male flowers mostly 1.5–2 mm. long. Leaves: stipules unequal, the longer of each pair c. 0.8–1.5 mm. long, triangular-lanceolate, attenuate-acuminate, not auriculate, entire, membranous-scarious, stramineous or brownish. Leaf-blades (6–) 8–20 (–25) mm. long, (2–) 2.5–6 (–9) mm. broad, membranous or somewhat firm, mostly oblong or oblong-obovate or nearly linear, sometimes slightly falcate, obtuse or acute and mucronulate at the tip, mostly obtuse and sometimes conspicuously asymmetric at the base; above bright or dark green, smooth, the raised midrib and laterals quite apparent; beneath pallid or sometimes reddish-tinged, minutely scabridulous on the face, hispidulous marginally and immediately intramarginally, midrib and the laterals (c. 5 on a side) raised and conspicuous, tertiaries forming a delicate, rather obscure reticulum.

Monoecious; well-developed branchlets nearly always floriferous; (5–) 8–15 (–20) proximal nodes with solitary female flowers; 5–10 (–15) succeeding distal nodes bearing abbreviated monochasia of 5–7 successively maturing male flowers; distalmost nodes and occasionally (here and there) some proximal nodes barren.

Male flower: Pedicel less than 0.5 mm. long, disarticulating above the middle. Calyx-lobes 6, elliptic to oblong-obovate, c. 0.3–0.45 mm. long, 0.2–0.4 mm. broad, obtuse, more or less entire, membranous, yellowish white, the midrib unbranched. Disk-segments 6, cuneate or roundish, c. 0.1 mm. across, obscurely glandular-papillate and crenulate. Stamens 3, filaments completely united into a slender column c. 0.1–0.15 mm. high; anthers sessile on the column but free from another, erect, c. 0.1–0.15 mm. long, 0.1 mm. broad; anther-sacs parallel, dehiscing vertically, the slits not confluent; pollen grains subprolate, c. 20 μ long and 16 μ broad, 4-colporate, colpi with median pores, exine finely reticulate.

Female flower: Pedicel 0.5 mm. long or shorter, green or reddish, smooth, terete, becoming greatly thickened in fruit. Calyx-lobes 6, erect at anthesis, reflexing in fruit, linear-oblong or lanceolate, 0.6–0.9 mm. long, 0.2–0.3 mm. broad, obtuse or rounded at the tip, hispidulous dorsally

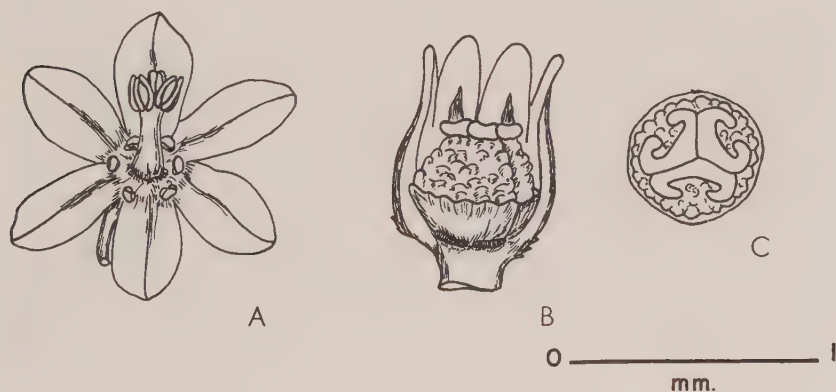
at the base and on the olivaceous or reddish slightly raised midrib area, yellowish, scarious, margins minutely serrulate or entire. Disk patelliform, thin, 6-angled or obscurely crenulate. Ovary spheroidal, olivaceous or reddish, conspicuously bullate-papillate; styles flattened and laterally fused at the base into a horizontal triangular plate 0.35–0.4 mm. across, c. $\frac{1}{3}$ parted, the branches divaricate and recurving at the tips.

Capsule c. 2–2.2 mm. in diameter, scurfy-tuberculate or nearly smooth, olivaceous or stramineous often with reddish blotches, nervation completely obscure. Seeds 1.1–1.2 mm. long, (0.8–) 0.9–1 mm. radially, 0.9–1 mm. tangentially, light greyish brown, with 12–15 sharp transverse ridges on the back and sides (these discrete or sometimes coalescing in pairs), often with 1–3 deep circular pits on the sides; hilum subterminal, depressed, more or less triangular.

Flowering all year.

TYPE: Ceylon, *Herb. Hermann* (BM). There are three specimens in Hermann's herbarium, of which vol. 4, fol. 55 probably represents the holotype, as it bears an annotated reference to Burman's description in the "Thesaurus Zeylanicus."

DISTRIBUTION: Native to Asia, introduced at scattered localities throughout the tropics.



TEXT-FIG. 9. *Phyllanthus urinaria* L. (Webster & Wilson 4923). A, male flower; B, female flower with two calyx-lobes removed; C, gynoecium and disk seen from above.

JAMAICA. ST. MARY: Castleton grounds, 490 ft., *Harris 12142* (C, F, P, S, US). ST. ANDREW: vicinity of Kingston, *Britton 1708* (NY); Hope Grounds, 650 ft. alt., *Harris 12155* (F, NY, P, S, US); Hope River Valley, *Harris 9980* (F, US). ST. THOMAS: Bath, in shady places, *Harris 12195* (C, F, P, US); Corn Puss Gap, *Webster & Wilson 4923* (A, JAM, MICH). PORTLAND: clay bank by roadside, Seamen's Valley, *Maxon & Killip 54* (F, NY, US); vicinity of Windsor, *Maxon & Killip 264* (F, NY, US).

LESSER ANTILLES. GUADELOUPE: Gourbeyre, *Duss* 213 (P); Pointe-à-Pitre, *Duss* 2922 (NY); champs cultivés, *L. Quentin* 88 (P); champs, alt. 100 m., *R. Quentin* 925 (P); Montebello, 60 m., *Questel* 438, 441 (US); Baillif aux Vieux-Habitants, *Stehle* 71 (US); friches de cannes-à-sucre, Pointe-à-Pitre, *Stehlé* 238, 500 (NY); Abymes, alt. 19 m., *Stehlé* 1193 (NY); Ste. Rose, champs et friches lateriques, *Stehlé* 1829 (US); Basse Terre, 1877, *Thiebaut* (P). DOMINICA: Rouseau Valley, *Lloyd* 558 (NY); roadside in cleared forest land, Sylvania Estate, alt. 549 m., *Hodge* 575 (NY). MARTINIQUE: St. Pierre, *Belanger* 292 *ex p.* (G); Troisième pont, *Hahn* 554 (G, L, P), 929 (P); Balata, *Mouret* (P); champ de bananes, Ravine-Vilaine, *Privault* 44 *ex p.* (P). ST. LUCIA: 1889, *Walsh* (NY); moist forest, *Velez* 3312 (US). ST. VINCENT: Montrose Hills, 800 ft., *Eggers* 6561 (US). GRENADA: Animas, mountains, banks in open places, *Broadway ex p.* (NY, mixed with *P. caribaeus*); Belvedere, 1600–1800 ft., *Eggers* 6111 (GOET, L, P, US); Mt. Pleasant, 1500 ft., *G. S. Miller* 159 (US). TOBAGO: damp ground, Caledonia, *Hunnewell* 19935 (GH). TRINIDAD: Port of Spain, *Wall* (S); St. Ann's, Cascade, on banks, *Broadway* 5057 (F, G, S); St. Joseph, D'Ade's Estate, in open ground, *Broadway* 2638 (F, G, L).

None of the West Indian collections seen of this species was made prior to 1850, so that it is evidently a comparatively recent introduction to our area. Even now, after more than a hundred years, it has not established itself on Cuba, Hispaniola, or Puerto Rico. Definitely mesophytic and one of the most shade-tolerant of the herbaceous species, it does not appear likely to become a serious weed.

Phyllanthus urinaria is obviously a foreigner in the West Indies, for it differs in many details from the superficially similar native species of sect. *Phyllanthus*. The transversely barred seeds and hispidulous leaves are unique in the West Indies, and the tuberculate ovary and sessile fruiting calyces offer additional characters which should make it one of the easiest species to identify. Furthermore, *P. urinaria* is distinguished physiologically from all of its congeners in our area by the sensitive reaction of the branchlets to touch; when a plant is disturbed sufficiently, the leaves fold together in the manner of *Mimosa pudica* leaflets, although much more slowly.

(To be continued)

STUDIES IN THE THEACEAE, XXIX
FURTHER STUDIES IN THE GENUS MELCHIORA

CLARENCE E. KOBUSKI

With four plates

SINCE DESCRIBING THE GENUS *Melchiora* last year (Jour. Arnold Arb. 37: 153–159. 1956), added information and material has come to my attention. Isotypes of new taxa, at that time either unknown or unavailable to me, have been added to our herbaria. Although these added specimens help confirm some of my suggestions they are still far too few in number for positive conclusions. It will probably be some time before enough material has been assembled to show conclusively whether two, three or even more taxa should be recognized. At present, two species and three varieties are recorded for the genus.

Photographs of the isotypes deposited in our herbaria are reproduced at the end of this paper.

MELCHIORA MANNII (OLIVER) KOBUSKI

Melchiora mannii (Oliver) Kobuski in Jour. Arnold Arb. 37: 155. 1956.

Adinandra mannii Oliver, Fl. Trop. Africa 1: 170. 1868. (See Kobuski, loc. cit. for more complete citation of literature).

This taxon is an endemic found only at the summit of the Pico on the island of São Tomé off the west coast of Africa in the Gulf of Guinea. Last year in discussing this taxon I quoted Exell as stating that he had made a search for *M. mannii* in November 1932 on the Pico in a “tremendous” rainstorm without success. He suggested that since a part of the summit had been cleared and planted with *Cinchona* it was possible that this taxon may have become extinct. In my apprehension over the taxon I mentioned forebodingly several instances where other taxa of this family had become extinct within our own generation. It is pleasant to be able to relate now that such is not the case.

Last October I received a pleased and excited letter from Prof. Th. Monod, Director of the Institut Français d’Afrique Noire at Dakar, stating that he had collected this species on a collecting trip to São Tomé. His is only the third collection of this species as far as I know (*Mann* in 1861 and *Campos* in 1907 are the other two) and the three collections were made at approximately fifty-year intervals!

Later Prof. Monod sent an excellent photograph showing eight flowers enlarged to near natural size. With his kind permission this photograph is being included in this paper. It shows remarkably well the “non spreading” character of the corolla, a most unusual character of this genus, very different from the spreading corolla of other members of the family.



FIGURE 1. Flowers of *Melchiora mannii* (Oliver) Kobuski collected and photographed by Prof. Th. Monod (no. 12228) from Pico, São Tomé, the type-locality.

THE MELCHIORA SCHLIEBENII COMPLEX

Whereas *M. manii* appears to be confined to a small area at the summit of Pico on São Tomé, *M. schliebenii* and its varieties enjoy a much wider distribution having been collected (from known reports in literature) eight times in Tanganyika, twice in Belgian Congo, and once in Uganda. Even so, this actually is a sparse representation considering the comments on the field notes of the various collectors. Melchior, in the original presentation of the species referred to a letter from the collector (Schlieben), who stated that in the type-locality (Uluguru, Tanganyika) the species comprised seventy percent of the trees. Greenway noted on his no. 6556 that var. *greenwayi* was common on the stream banks in the Pare District, Tanga Province. Boutique and Troupin term var. *intermedia* the dominant feature of the forests in the Lake Kivu area of the Belgian Congo.

A distribution as extensive as this is enjoyed by only a few taxa in the family Theaceae and these taxa, in turn, are notorious in the variability of the usually "reliable" characters. One of these characters is pubescence and it is this character which in *M. schliebenii* shows the most variation. Only a much larger collection of material will show how stable this character is in the present group.

All the types of pubescence found on the taxa described in this complex are of the evanescent type, so common in the family. The leaves of var. *greenwayi*, densely pilose in the buds and younger growth become glabrous or glabrescent at maturity. The fine appressed pubescence found on the inner side of the sepals will wear off as will the thick pilose pubescence on the ovary and style. No fruiting material of the genus has been available to me for study. Melchior in his original presentation described the fruit of *M. schliebenii* and Boutique & Troupin, in turn included a description of the fruit of var. *intermedia* (*Adinandra intermedia*) in their work. In neither instance was any mention made of pubescence, hence one is justified in assuming that the fruit is glabrescent.

Verdcourt (Kew Bull. 1955: 609. 1956) in a discussion of this complex separates the varieties of *M. schliebenii* (as *Adinandra schliebenii*) on the pubescence of ovary, leaves and sepals. An adaptation of his key using the same characteristics is as follows:

- A. Ovary glabrous. *M. schliebenii* var. *glabra*.
- AA. Ovary pilose.
 - B. Leaves pubescent to velutinous below. *M. schliebenii* var. *greenwayi*.
 - BB. Leaves glabrous entirely.
 - C. Inner sepals \pm pubescent outside. . . *M. schliebenii* var. *schliebenii*.
 - CC. Inner sepals glabrous outside. *M. schliebenii* var. *intermedia*.

In making a key to members of this family where pubescence is involved I have found in genus after genus that one of the most reliable basic characters is found in the terminal leaf-bud, which is usually present in most specimens. Only in the truly glabrous specimen will the leaf-bud be glabrous. In a pubescent or glabrescent specimen the leaf-bud will be

pubescent. This character is quite consistent throughout the whole family. A key based primarily on the leaf-bud character (differing but little from Verdcourt's key) would appear as follows:

- A. Leaf-buds glabrous.
 - B. Ovary and lower part of the style pubescent.
 - C. Sepals and bracts glabrous on the interior side and pubescent on the unexposed (portion concealed by the imbrication in the bud) part of the exterior side. 1. *M. schliebenii* var. *schliebenii*.
 - CC. Sepals and bracts appressed pubescent on the interior side and glabrous or quickly glabrescent on the exterior side. 2. *M. schliebenii* var. *intermedia*.
 - BB. Ovary and style glabrous. 3. *M. schliebenii* var. *glabra*.
- AA. Leaf-buds pubescent. 4. *M. schliebenii* var. *greenwayi*.

Melchiora schliebenii (Melchior) Kobuski in Jour. Arnold Arb. 37: 156. 1956.

Adinandra schliebenii Melchior in Notizbl. Bot. Gard. Mus. Berlin 11: 1076, 1097. 1934. — Kobuski in Jour. Arnold Arb. 28: 95. 1947. — Boutique & Troupin in Bull. Jard. Bot. Bruxelles 20: 65. 1950. — Verdcourt in Kew Bull. 1955: 608. 1956.

1. *Melchior schliebenii* var. *schliebenii*

TANGANYIKA TERRITORY: Uluguru, in fog forest northwest side of Lupanga Mountains; tree 20–30 m., flowering and fruiting, with orange and red flowers, *H. J. Schlieben* 3175 (ISOTYPES, AA and Yale), December 28, 1932.

During a recent conversation with Dr. William L. Stern, Curator of the Wood Collection and Herbarium of the Yale School of Forestry, I learned to my surprise that a set of the Schlieben collection from Tanganyika had been deposited at that institution. He has checked and sent me for annotation a sheet of the type-collection of this species. This is excellent news, indeed, since the Yale specimen proves to be the more complete of the two specimens examined. Up until recently, the type-collection cited above was the only representative of the species. However, another collection, *Drummond & Hemsley* 1766, from the same area is deposited in the herbarium of the Royal Botanic Garden at Kew and cited by Verdcourt in his most recent work.

Like var. *intermedia* this taxon has glabrous leaf-buds, with the ovary and lower part of the style pubescent.

The sepals and bracteoles, however, are glabrous on the interior side and pubescent on the unexposed parts of the exterior side. The disposition of the pubescence on the inner three sepals is very interesting and very characteristic of many taxa in the family Theaceae. The portions of the exterior side of the sepals exposed in the bud are glabrous. This means that the two outer sepals are entirely glabrous. The next two sepals are pubescent on the half side which is covered while the uncovered half is glabrous. The inner sepal, because of its position in the imbrication is generally pubescent over the entire exterior surface or generally so.

Melchiora schliebenii (Melchior) Kobuski var. **intermedia** (Boutique & Troupin) Kobuski, comb. nov.

Adinandra intermedia Boutique & Troupin in Bull. Jard. Bot. Bruxelles 20: 62. 1950.

Adinandra schliebenii Melch. var. *intermedia* (Boutique & Troupin) Verdcourt in Kew Bull. 1955: 608. 1956.

Melchiora intermedia (Boutique & Troupin) Kobuski in Jour. Arnold Arb. 37: 157. 1956.

Adinandropsis, sp. nov. Pitt-Schenkel in Jour. Ecol. 26: 80. 1938, nom. nud.

BELGIAN CONGO: PROV. KIVU: Mayamoto, forêt ombrophile de montagne, fond de ravin, alt. 2350 m., *A. Michelson* 742 (TYPE, BRLU; ISOTYPE, A), Déc. 1947.

We appreciate very much and are most grateful to the Jardin Botanique de l'Etat of Brussels for sending us an isotype of this taxon for our herbaria. Besides the type which was collected in Belgian Congo, Boutique and Troupin cited three other specimens, a second from the type region, and one each from Kigezi in Uganda and Mt. Usambara in the Territory of Tanganyika. This area of distribution comprises a region extending well over seven hundred miles and the authors report the taxon to be the dominant plant of the Kivu region.

The sepals and bracts are glabrous on the exterior surface and appressed pubescent on the interior surface. In this character it is similar to var. *greenwayi*. However, the latter variety has leaf-buds and, of course, mature leaves which are strictly glabrous.

Melchiora schliebenii (Melchior) Kobuski var. **glabra** (Verdcourt) Kobuski, comb. nov.

Adinandra schliebenii Melchior var. *glabra* Verdcourt in Kew Bull. 1955: 608. 1956.

NO SPECIMENS EXAMINED.

This appears to be a completely glabrous variation of the typical variety. In the original description Verdcourt mentions only the glabrous ovary. However, in his short discussion he states that he had considered including the new variety under var. *intermedia* but because of the "peculiar" plants as yet undescribed from the area of the W. Usambaras he suggested that the glabrous ovary may be correlated with a limited distribution.

Two specimens were cited by Verdcourt [*Procter* 183 (EA) and *Drummond & Hemsley* 2536 (K)] both collected in the Lushoto District at altitudes of 2220 m. and 2230 m. respectively. Furthermore, it was suggested by the collectors that both representatives grew on the exposed ridgetops or, when in the forests, in the drier parts.

It is not unusual for taxa in the family Theaceae to take on a glabrous character when found growing in high dry exposed places.

Unfortunately, no duplicates of the type of this variety have been available to me. It would be interesting to know whether the interior side of

the bracts and sepals are appressed pubescent as in var. *intermedia* or are strictly glabrous.

Melchiora schliebenii (Melchior) Kobuski var. **greenwayi** (Verdcourt) Kobuski, comb. nov.

Adinandra greenwayi Verdcourt in Kew Bull. 1953: 84. 1953.

Adinandra schliebenii Melchior var. *greenwayi* (Verdcourt) Verdcourt in Kew Bull. 1955: 608. 1956.

TANGANYIKA TERRITORY: TANGA PROV.: Pare Distr., S. Pare Mts. Mtonto, alt. 6500 ft., locally common on stream banks in *Ocotea-Podocarpus-Rapanea-Myrica* evergreen forest on steep mountain slopes, *P. J. Greenway* 6556 (TYPE, K; ISOTYPES A and EA), July 5, 1942 (much branched evergreen tree with ascending branches up to 80 ft. tall; the bark reddish brown, much fissured in reticulate patches; the flowers large tubular creamy brown with green tipped petals; the mature leaves with a brownish cream band each side of the main vein).

A very ample specimen of the type number of this taxon was given us by the East African Herbarium at Nairobi, Kenya, East Africa.

The sepals and bracts as in var. *intermedia* are glabrous on the exterior surface and appressed pubescent on the interior surface. However, the terminal leaf-buds differ from all other taxa in this complex in being tomentose. This character is retained into the younger stages of the mature leaves but later in the older leaves tends toward glabrescence. This taxon may represent the original entity in the complex.

At present these varieties seem clearly distinguishable. One must remember, however, that the species is one of wide distribution and is found in considerable abundance in several areas. The herbarium specimens available for study are as yet far too few in number to assume that the varieties recorded above will be maintained when further collections are examined, as they are based primarily on the pubescence, a character very variable in this family. As I mentioned before, I feel that the original element in the complex is var. *greenwayi* and that the other three are variations from it, with var. *glabra* the most recent and perhaps the least dependable of the group.

ARNOLD ARBORETUM AND GRAY HERBARIUM,
HARVARD UNIVERSITY.

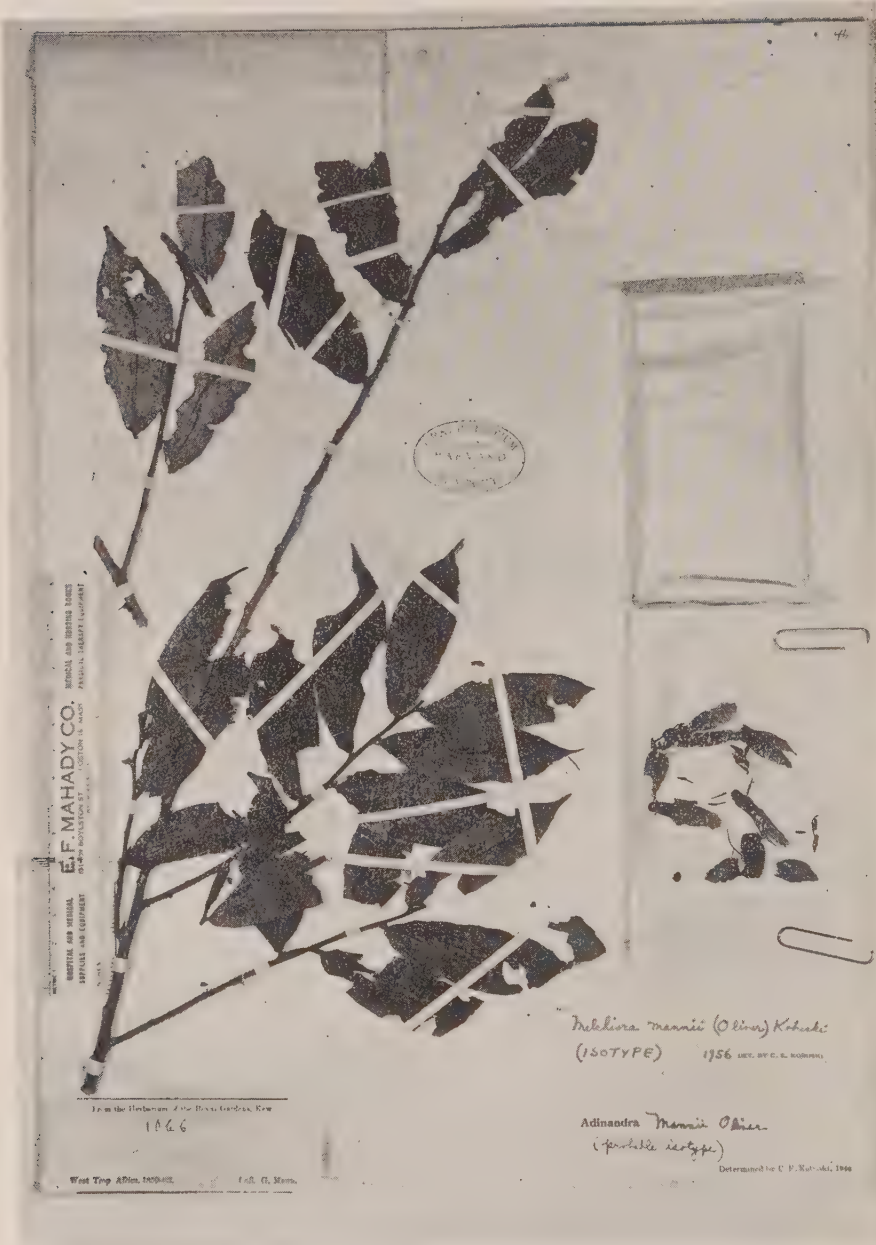
EXPLANATION OF PLATES

PLATE I. Isotype of *Melchiora mannii* (Oliver) Kobuski. *G. Mann 1066* in the Gray Herbarium.

PLATE II. Isotype of *Melchiora schliebenii* (Melchior) Kobuski. *H. J. Schlieben 3175* in Yale University.

PLATE III. Isotype of *Melchiora schliebenii* (Melchior) Kobuski var. *intermedia* (Boutique & Troupin) Kobuski. *A. Michelson 742* in the Arnold Arboretum.

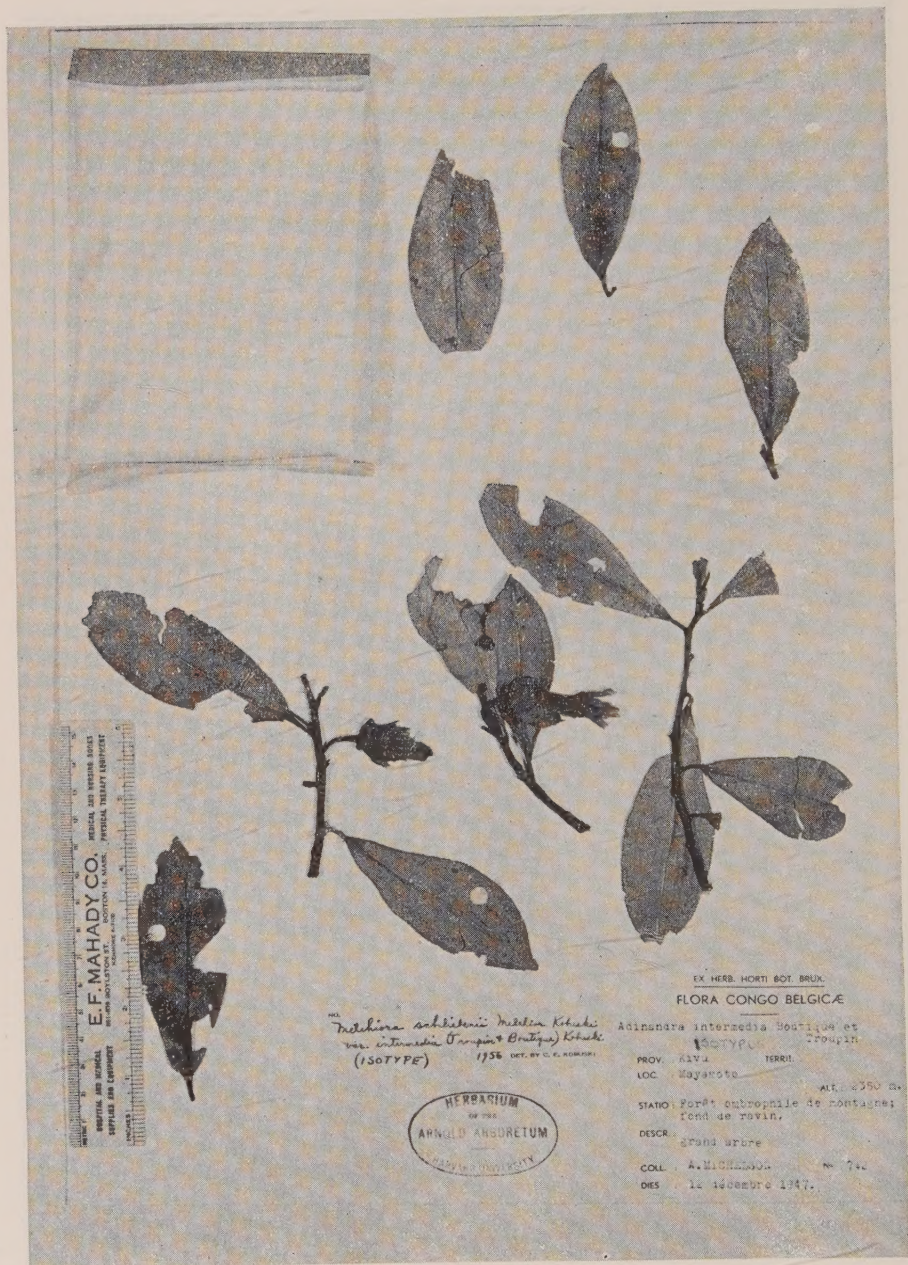
PLATE IV. Holotype of *Melchiora schliebenii* (Melchior) Kobuski var. *greenwayi* (Verdcourt) Kobuski. *P. J. Greenway 6556* in the Royal Botanic Garden, Kew.



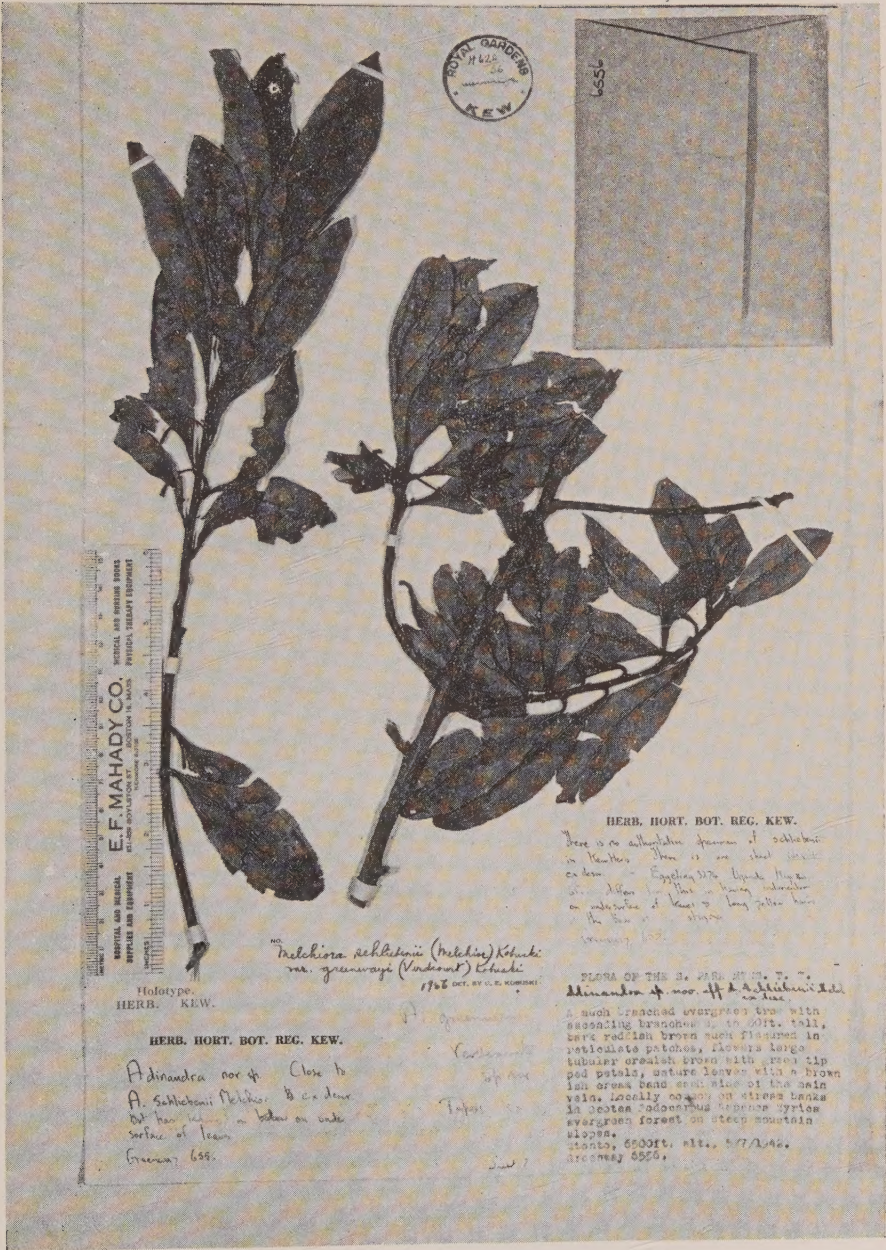
MELCHIORA MANNII (OLIVER) KOBUSKI



MELCHIORA SCHLIEBENII (MELCHIOR) KOBUSKI



MELCHIORA SCHLIEBENII (MELCHIOR) KOBUSKI
VAR. INTERMEDIA (BOUTIQUE & TROUPIN) KOBUSKI



MELCHIORA SCHLIEBENII (MELCHIOR) KOBUSKI
VAR. GREENWAYI (VERDCOURT) KOBUSKI

